2023/2024

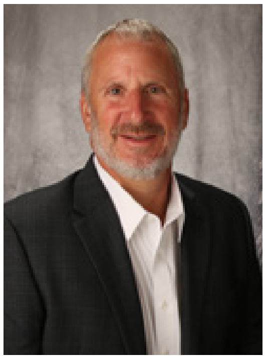
National Tile Contractors Association

REFERENCE MANUAL

PROBLEM CHARACTERISTICS

CAUSE • CURE • PREVENTION

A LETTER FROM THE **EXECUTIVE DIRECTOR**



Bart A. Bettiga

The National Tile Contractors Association is proud of the leading role it has played in the growth of the tile industry. One of the most important accomplishments in our history has been the publication of the *NTCA Reference Manual*. Thanks to the leadership of Robert Roberson of the David Allen Company in the 1980's, the NTCA Technical Committee was re-established and contractors and industry leaders began meeting regularly to address issues related to installation of ceramic tile and natural stone.

Joe Tarver, the NTCA Executive Director and his staff began compiling the documents into a binder to share with NTCA Members. The *NTCA Reference Manual* was soon published and a valuable member benefit was created.

The *NTCA Reference Manual* is now one of the most highly-valued tile industry documents. In 2016, the NTCA Board of Directors voted to make the manual available to the entire industry. We believe every tile professional involved in specifying, designing, selling and installing ceramic tile should have a current copy of the manual and it should be kept nearby, along with ANSI standards and the *Tile Council of North America (TCNA) Handbook for Ceramic, Glass, and Stone Tile Installation*.

The NTCA Technical Committee is comprised of some of the leading experts in the industry. These members are carefully selected for their expertise in all segments of our trade. On behalf of the NTCA, I would like to personally thank each of those individuals who have generously donated their time and knowledge to make the *NTCA Reference Manual* the valuable document it is today.

The purpose of the *NTCA Reference Manual* is to identify recurring challenges to successful installations of tile and stone, recognize potential problems, and to gain consensus from industry experts on offering solutions. Our manual is quite different from invaluable resources available in our industry like the *TCNA Handbook* and the ANSI standards for tile, stone and glass tile manufacturing and installation. In fact, we believe the *NTCA Reference Manual* complements these standards and belongs next to them on every industry professional's computer or office desk. That is why we offer it to everyone at an affordable price.

We realize that developing these documents and assuring their accuracy is a never-ending process. We appointed sub-committees to fully review each section and we expect continued revisions to existing documents in addition to developing new documents on an annual basis. We have inserted photographs in some instances to highlight the issues, and we intend to continue to enhance our manual in this fashion in the future. There has been significant revisions made in this year's version thanks to the countless hours donated by members of these sub-committees.

It is important to note that we have created a glossary of terms over the years to help individuals understand the terminology of our trade. We encourage suggestions to add or revise these terms at any time. This is true for all of our documents. In addition to our traditional problem, prevention and cure format, we also offer numerous letter templates that can be used or modified to address common issues in documentation and negotiation on the jobsite. Many of our members over the years have saved thousands of dollars using these templates and we encourage you to do the same. We now also offer general position statements on many issues as well.

Finally, you will notice selected advertising in the *NTCA Reference Manual*. This is NTCA's way of thanking our associate supporters who have played such an integral role in the development of these documents. All of the companies who have placed advertising in this manual have supported NTCA with membership, sponsorship, technical guidance and assistance in the development of our documents. We urge all of our contractor and distributor readers to support our associate members whenever possible.

On behalf of our staff, officers and committee and board members, we hope you enjoy the *2023/2024 NTCA Reference Manual*, and we urge you to tell others of its value.

Sincerely,

Bart

Bart Bettiga
NTCA Executive Director

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NTCA would not be possible without the dedicated service of our board and committee members, and regional and ambassador directors. Meet these dedicated volunteers by visiting www.tile-assn.com and clicking on "About Us". You can also find information and a continually-updated list of NTCA Five-Star Contractors at www.tile-assn.com – click on Find a Tile Contractor or Consultant.

ON THE COVER:
NTCA Five-Star Contractor
Project of the Year Residential Grand Prize Award Winner

Lambert Tile and Stone
Eagle, Colorado

Lambert Tile and Stone of Eagle, Co. was awarded the 2023 NTCA Five-Star Project of the Year Residential Grand Prize for their outstanding work on the Mountain Glam project. The ambitious project involved installing over 3,300 square feet of Gauged Porcelain Tile Panels (GPTP) throughout the home. More images of this award winning project can be seen throughout this edition of the NTCA Reference Manual. Congratulations Lambert Tile and Stone!

Reference Manual and Specifications

THIS REFERENCE MANUAL IS PUBLISHED AS A DIRECT RESULT OF THE EFFORTS OF THE TECHNICAL COMMITTEE OF THE NATIONAL TILE CONTRACTORS ASSOCIATION, INC.

MISSION STATEMENT FOR THE
NATIONAL TILE CONTRACTORS ASSOCIATION, INC. TECHNICAL COMMITTEE

THE NTCA TECHNICAL COMMITTEE
The NTCA Technical Committee, a body of highly skilled and experienced members encompassing all segments of the industry, identifies recurring problems encountered by NTCA members, recognizes potential problems and addresses those problems through regularly scheduled meetings. The use of existing technical information and the development of new and innovative documents comprise the contents of the *NTCA Reference Manual*, which is the direct result of the committee's efforts. The committee acknowledges the contributions of every member and is cognizant of its role in and its commitment to the total industry; however, its primary focus and concern are in the best interest of the National Tile Contractors Association and its contractor members.

WHAT IS THE NTCA REFERENCE MANUAL?
The *NTCA Reference Manual* is a comprehensive culmination of knowledge, research, development and publication of the efforts of the NTCA Technical Committee. While the *NTCA Reference Manual* may refer to ANSI, ASTM, TCNA and/or other publications, its content does not represent an Industry Standard and is intended to educate those engaged in tile and stone installation, particularly the contractor members of NTCA. Critical and pertinent information in the *NTCA Reference Manual* is disseminated through members, in *TileLetter*, *TileLetter ARTISAN* and other carefully selected industry and non-industry publications.

Limitation on Use and Disclaimer

The contents of this manual, other than current approved specifications, are not a specification and should not be quoted or referenced in construction plans or specifications to describe the manner of construction, the materials and products to be used, or for any like purpose. Reference to proprietary products does not imply knowledge of compliance or non-compliance with industry methods, standards, specifications or codes. The illustrations and descriptions have not been tested or professionally evaluated by NTCA. They are the compilation of the individual experiences of industry members and the NTCA Technical Committee. It is intended only to offer possibilities for causes, correction, and prevention of industry problems; and is to be used with the judgment and experience of the individual craftsman. NTCA expressly disclaims any compliance, guarantees or warranties, expressed or implied, for anything described or illustrated herein; and assumes no responsibility for errors or omissions.

The National Tile Contractors Association, Inc. is an equal opportunity association and seeks to include qualified individuals and businesses in all phases of its activities. The National Tile Contractors Association, Inc. does not discriminate on the basis of race, color, religion, age, sex, sexual orientation, national origin, veteran status, or disability. The National Tile Contractors Association, Inc. seeks opportunities to include these groups in its programs and activities.

It is the policy of the National Tile Contractors Association, Inc. to comply fully and in good faith with the letter and spirit of all antitrust laws and all other laws regulating conduct and trade in the United States. In that regard, members shall not discuss or agree upon prices, pricing policies, bids, freight charges, discounts, surcharges, allowances or other terms and conditions of sale; nor shall they discuss or agree upon supply restrictions, the allocation of customers or markets, group boycotts, or any other activities that have the purpose or effect of lessening competition. These restrictions apply to all meetings and other forms of communication among members, whether formal or informal.

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Photo courtesy of Trostrud Mosaic & Tile Co., Inc., 2023 NTCA Five-Star Project of the Year Commercial Grand Prize winner.

Technical Committee Changes to the 2023-24 NTCA Reference Manual

The NTCA Technical Committee is comprised of leading experts in the tile, stone and allied products industry who continually work to update, revise and add new documents to the *NTCA Reference Manual*. The NTCA Technical Committee meetings are held twice a year and are open to the public. The NTCA encourages your attendance and participation in the important work of the Committee.

Changes to the *2023-24 NTCA Reference Manual* are made at the discretion of the NTCA Technical Committee members serving on the Committee. See the NTCA Technical Committee Roster on pages 2-3.

A special thank you to Becky Serbin, NTCA Education and Curriculum Director, for the countless hours she has spent and continues to spend going through some of the editorial changes in this edition.

EDITORIAL UPDATES

NEW

Table of Contents

1

GENERAL REQUIREMENTS

Photo courtesy of the National Tile Contractors Association

Photo courtesy of the
National Tile Contractors Association

Chapter 1
General Requirements

General Statement on Moisture Emissions

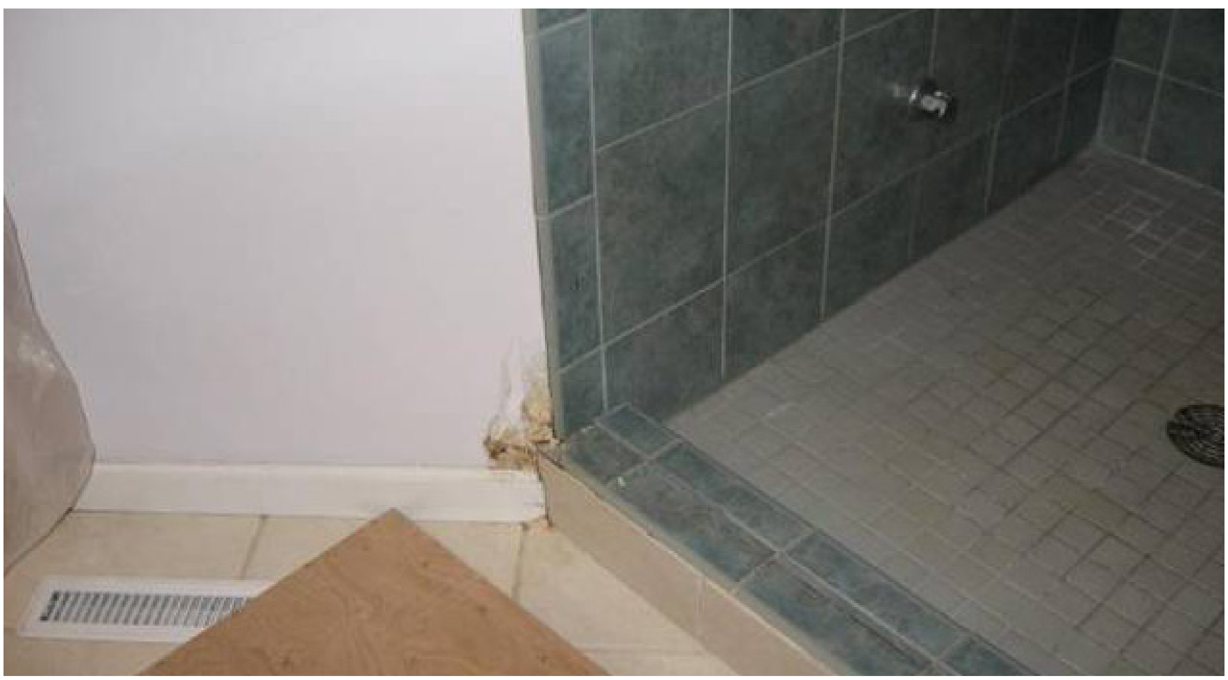
PURPOSE: The intention of this general statement is to bring to the attention of the tile contractor the problems of moisture emission in certain installations.

Many conventional tile installations have few problems with moisture emission. Ceramic tile typically does not have the same type of problems as wood, carpet, and vinyl when it comes to moisture emissions in as much as the moisture typically does not affect tile installations; however, some other flooring materials either do not allow moisture to pass through them, or may be sensitive to moisture and therefore may be adversely affected by moisture. A tile contractor should be careful when installing the following materials over concrete slabs:

- Agglomerate tiles - (cement or resin based)
- Stone tiles
- Setting with epoxy
- Grouting with epoxy
- Non-vitreous tiles with epoxy grout
- Terrazzo tiles
- Efflorescence (cement grouts)
- Organic adhesives
- Concrete tiles
- Crack-isolation or waterproof membranes

In these installations, the membrane, setting material and tile or stone manufacturer should be contacted for further instructions and for moisture emission protection requirement.

The tile contractor should bring any issues of the substrate to the general contractor's attention (or owner, if there is no general contractor). The general contractor, builder, or owner should pay for random Calcium Chloride tests (ASTM F1869-04). The tile contractor/general contractor or tile contractor/owner should agree on who will perform the tests, and what kind of moisture test should be done.



Moisture spots indicate there is moisture intrusion. Water that gets to cavities with a food source for mold will generate these kinds of problems. It makes sense to take the steps necessary to prevent these problems (and liabilities) for your business. Photo courtesy of Noble Company.

Photo courtesy of Nichols Tile & Terrazzo Co., Inc.

TCNA HANDBOOK
ENVIRONMENTAL CLASSIFICATIONS

The end user significantly affects the amount of water and vapor an installation will be exposed to. Examples provided below and the classifications assigned to the individual methods are guidelines only and are not meant to be all inclusive. Base installation method selection on actual exposure levels, and consult with product manufacturers and their specifications. In methods where inclusion of a waterproof membrane is optional, the design professional must clearly specify that a membrane is desired. Optional membranes are not included unless clearly specified.

Res1 (Residential Dry): Tile surfaces that will not be exposed to moisture or liquid, except for cleaning purposes. Includes areas adjacent to R2 areas. Examples: Floors in rooms with no direct access to the outdoors and no wet utility function, such as living rooms, dining rooms, and bedrooms; dry area ceilings, soffits, decorative/accent walls, fireplaces, some backsplashes and some wainscots.

Res2 (Residential Limited Water Exposure): Tile surfaces that are subjected to moisture or liquids but do not become soaked or saturated due to the system design or time exposure. If waterproofing is desired, it must be clearly specified. Includes areas adjacent to R3 areas. Examples: Floors in bathrooms, kitchens, mudrooms, laundry, and foyers, where water exposure is limited and/or water is removed; some backsplashes, some wainscots, some countertops.

Res3 (Residential Wet): Tile surfaces that are soaked, saturated, or regularly and frequently subjected to moisture or liquids. Examples: Shower floors; floors and other horizontal surfaces where water is not removed or drained, such as some countertops; tub walls, shower walls, and enclosed pool area walls.

Res4 (Residential High Humidity, Heavy Moisture Exposure): Tile surfaces that are subject to continuous high humidity or heavy moisture exposure. Examples: Intermittent-use steam shower walls, ceilings, and floors.

Res5 (Residential High Temperature ≥125ºF): Tile surfaces frequently subjected to water or vapor equal to or greater than 125ºF. Examples: Furnace and boiler areas.

Res6 (Residential Exterior): Tile surfaces exposed to exterior conditions. When designing such installations, consider local climate and conditions including temperature and temperature fluctuations, humidity and humidity fluctuations, and freeze/thaw cycling. If waterproofing is desired, it must be clearly specified. Examples: Exterior walls, balconies, decks.

Res7 (Residential Submerged): Tile surfaces exposed to continuous water submersion in interior or exterior conditions. Examples: Swimming pools, water features, and fountains.

Com1 (Commercial Dry): Tile surfaces that will not be exposed to moisture or liquid, except for cleaning purposes. Commercial cleaning and maintenance practices typically generate greater water exposure than residential practices. Includes areas adjacent to C2 areas. Examples: Floors in areas with no direct access to the outdoors and no wet utility function, such as hallways; dry area ceilings; soffits; decorative/accent walls; corridor walls.

Com2 (Commercial Limited Water Exposure): Tile surfaces that are subjected to moisture or liquids but do not become soaked or saturated due to the system design or time exposure. If waterproofing is desired, it must be clearly specified. Includes areas adjacent to C3 areas. Examples: Floors in bathrooms and locker rooms; some backsplashes and other walls, such as bathroom walls and wainscots where water exposure is limited and/or water is removed.

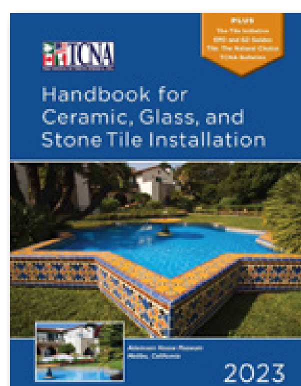
Com3 (Commercial Wet): Tile surfaces that are soaked, saturated, or regularly and frequently subjected to moisture or liquids. Includes areas adjacent to C4 areas. Examples: Tub walls, shower walls and floors, enclosed pool areas, natatoriums, gang showers, and some commercial kitchen floors and walls.

Com4 (Commercial High Humidity, Heavy Moisture Exposure): Tile surfaces that are subject to continuous high humidity or heavy moisture exposure, especially in enclosed areas. Examples: Continuous use steam shower/ steam room walls and ceilings.

Com5 (Commercial High Temperature ≥125ºF): Tile surfaces that are frequently subjected to water or vapor equal to or greater than 125ºF. Examples: Commercial saunas, furnace and boiler areas, and some commercial kitchen floors and walls.

Com6 (Commercial Exterior): Tile surfaces exposed to exterior conditions. When designing such installations, consider local climate and conditions including temperature and temperature fluctuations, humidity and humidity fluctuations, and freeze/thaw cycling. If waterproofing is desired, it must be clearly specified. Examples: Exterior walls, balconies, decks.

Com7 (Commercial Submerged): Tile surfaces exposed to continuous water submersion in interior or exterior conditions. Examples: Swimming pools, water features, and fountains.



Source: Excerpted from "Environmental Exposure Classifications," in *TCNA Handbook for Ceramic, Glass, and Stone Tile Installation*, pp. 47. Anderson, SC: Tile Council of North America, 2023. © 2023 Tile Council of North America. Reprinted by permission.

Photo courtesy of Bergeson Tile

Temporary Protection for Tiled Surfaces – Sample Letter to Owner/General Contractor

NOTES TO THE TILE CONTRACTOR

Sample letter should be modified to accommodate your specific circumstances. For example, there may be some control provided that you may wish to acknowledge.

Date

Company
Address
City, State Zip

Re: Project
Protection of Ceramic, Glass and Stone Tile Floor Finish Assemblies

Contact:

This letter is to inform you about the need for protection of ceramic, glass or stone tile floor finish assemblies installed at the referenced project.

Tile is susceptible to cracking from exposure to heavy concentrated loads such as those from scissor lifts, telescoping lifts, hydraulic pallet jacks, vending machines, or kiosks used or installed both during construction, as well as equipment used for maintenance or deliveries after completion of construction.

Tile is particularly at risk of cracking from exposure to heavy equipment loads within the first 7 days after installation while the underlying adhesive mortar is still curing and developing proper strength to fully support heavy loads. Similarly, tile installed over flexible crack-isolation or sound control membranes may also be at risk of cracking from exposure to heavy concentrated loads, even after underlying tile mortars are fully cured.

Therefore, we strongly recommend that both fully-cured tile installations, and especially fresh tile installations, be protected by applying sheets of plywood or other suitable protection boards to distribute the loads imposed by heavy equipment.

The type and suitability of protection should be determined/checked by a licensed professional engineer.

Protection should be provided not only beneath the final working position of such equipment, but also in the path of travel to and along the working position, since tile is particularly sensitive to the combination of heavy loads and the torsion or shearing effect that can be caused by turning of wheels in direct contact with the tile surface.

Please also refer to other tile industry standards such as the *Tile Council of North American Handbook for Ceramic, Glass and Stone Tile Installation* and the ANSI A108 series for Ceramic Tile Installation for additional information about protection of both new and existing tile floor finish assemblies.

Name and Title
Company

Photo courtesy of Vesta Tile & Stone, LLC

Photo courtesy of Bostik

2

SUBSTRATES

Photo courtesy of National Ceramic Tile and Stone Corp. 2023 NTCA Five-Star Project of the Year Commercial Elite Grand Prize winner.

Chapter 2
Substrates

Proper Preparation and ANSI Requirements for Thin-Set Method Tile Installation

Concrete Slabs ☐

1. Do not apply curing compounds or topical sealers to concrete slabs receiving thin-set method tile installations.

2. Protect concrete slabs from oil, grease, and other contaminants.

3. Some job-site heaters and portable fuel heaters may emit contaminants that may be detrimental to direct mortar bond installations on concrete.

4. Trowel slabs and then give a light broom finish to achieve the best bond of the thin-set mortar to the slab. Highly polished or mechanically finished slabs may not be conducive to mortar adhesion.

5. Maximum permissible variation 1/4 in. in 10 ft. (6 mm in 3 m) with no more than 1/16 in. per 12 in. (2 mm in 305 mm) variation from the required plane, except as required for drainage. For tiles with at least one edge 15 in. (0.38 m) or larger, 1/8 in. in 10 ft. (3 mm in 3 m) with no more than 1/16 in. per 24 in. (2 mm in 610 mm) variation from the required plane.

6. If the floor is expected to drain, the slab shall be placed with the appropriate pitch for the specified tile material.

7. If the drains are not adjustable, set the drains above the slab to accommodate the specified tile and setting material. Do not pack an adjustable drain weep with mortar or other solid material. Consider using a manufactured drain assembly. For thicker tile or paver material, seek the advice of a qualified tile contractor.

8. It is the responsibility of the owner, project designer or architect to specify and locate control joints. Give careful attention to the plans, specification requirements, and locations for all expansion joints, control joints, and cold pour joints. Required joints should be on straight lines and exact angles that will conform to the tile joint location.

Masonry Walls ☐

1. Erect walls with correct angles, straight, square and plumb to within 1/4 in. in 10 ft. (6 mm in 3 m) and no more than 1/16 in. per 12 in. (2 mm in 305 mm) variation from the required plane. For tiles with at least one edge 15 in. (0.38 m) or larger, 1/8 in. in 10 ft. (3 mm in 3 m) and no more than 1/16 in. in 24 in. (2 mm in 610 mm) variation from the required plane. Failure to provide walls according to these standards cannot be corrected by a thin-set. Thinset mortar is not intended to be used to true or level substrates.

2. Strike joints flush and prepare the same as if they were to be painted.

3. Erect inside and outside corners square and free of excess mortar.

4. Block filler or paint shall not be used on surfaces to receive tile.

Drywall ☐

1. Erect stud walls with correct angles, straight, square and plumb with stud faces forming a flat plane. Interior angles or changes in plane shall be framed or blacked to provide solid backing for interior corners. For tiles with at least one edge 15 in. (0.38 m) or larger, 1/8 in. in 10 ft. (3 mm in 3 m) and no more than 1/16 in. in 24 in (2 mm in 610 mm) variation from the required plane. Failure to provide walls according to these standards will require preparation prior to installation of materials. Thinset mortar is not intended to be used to true or level substrates. Out of tolerance walls cannot be corrected by thinset mortar.

2. Tape all joints and eliminate voids. In wet areas, use water alkali-resistant tape.

3. Eliminate corner beads from out-corners that are to be wrapped with tile.

4. Square inside and outside corners.

5. Install drywall 1/4 in. (16 mm) above the floor and where the vertical surface intersects with horizontal surfaces, such as tub rims.

6. Unprotected gypsum drywall is not a recommended substrate for thin-set tile installations in wet areas.

7. Caution: when metal straps are installed over studs, in lieu of between studs to provide support for wall hung fixtures, grab bars, etc., shimming the remainder of the studs the same thickness as the supports and screws is required prior to installing dry wall to provide a suitable substrate to cover with tile.

NOTES TO THE TILE CONTRACTOR

The suggested sample letter shown here is to transmit with a copy of page 24 to the General Contractor.

It is also suggested that additional copies be sent marked for all parties involved, i.e. project manager, superintendent, drywall contractor, masonry contractor, and concrete finishers.

Hydration reactions of Portland cement:
Tricalcium silicate and beta-dicalcium silicate constitute about three quarters of the weight of a typical Portland cement powder. The remaining fraction consists chiefly of tricalcium aluminate and tetracalcium aluminoferrite. Under ordinary temperature conditions, and with adequate water available, the hydration of the latter two constituents is essentially complete within 7 days. Hydration of the tricalcium silicate, although well advanced at this time, may require a year or longer for essential completion, while the hydration of dicalcium silicate is appreciable only after several months, approaching completion after several years.
Drexel Institute of Technology
Philadelphia, PA

Date

Company
Address
City, State Zip

Re: Project
Tile Preparation

Contact:

The specifications for this project require a thin-set tile installation. I believe it will be helpful to all trades involved to point out the specification requirements.

I have enclosed a copy of the "Proper Preparation and ANSI Requirements for Thin-set Method Tile Installations."

Please ask each trade involved to be guided accordingly. Adherence to these requirements will assist in obtaining a proper tile installation.

Should anyone have any questions, please contact me.

Name and Title
Company

Encl.

Photo courtesy of Ceramic and Stone Solutions

Curing Compounds, Release Agents, and Sweeping Compounds

Curing Compounds	Form Release Agents and Sweeping Compounds	Correction
Curing compounds shall not be used where tile, stone, and mortar beds are bonded directly to the surface. These surfaces shall be wet/damp cured. Manufacturers claim some resinous concrete curing compounds and sealers have been formulated and designed to lay on the surface of the concrete, become brittle as they age, and flake off with traffic and time, leaving no residue. It is claimed that use of these types of resinous curing compounds will have no effect on the bonding of tile to that surface. Industry support organizations and the tile industry's experience indicate otherwise, and these claims should not be accepted. There is a strong possibility that tile installed on these type surfaces will lose bond, produce a hollow sound, and result in cracked or broken tile or stone. Other types of "cure and seal" curing compounds based on fluosilicates that combine chemically with the free lime in Portland cement have been declared as not conforming with concrete curing requirements, and may also cause the same problems as the resinous materials. This type of material should not be used without a full and complete labor and materials guarantee from the curing compound manufacturer if these are and must remain in place.	Form release agents used in concrete construction and slab release agents used in lift slab construction often make the same claims as those made for concrete curing compounds. The same cautions apply for these materials as for concrete curing compounds. They are unacceptable for use where tile, stone and mortar beds are bonded directly to the surface. Obtain the full and complete labor and materials guarantee and understand any limitations or conditions for removal of form release agents imposed by the manufacturer before proceeding with the tile and stone installation. Sweeping compounds – oil based and wax based – are used during the duration of the construction process to keep dust down. The sweeping compounds close the pores in the concrete and self-leveling substrates, acting as a bond breaker.	These suggested corrections and/or a combination of suggested corrections may provide improved conditions and a serviceable product. **Shot-Blasting** A very effective method involving metallic abrasives thrown at high velocity by a rapidly rotating blast wheel. This system includes a built-in vacuum process that minimizes dust. **Water Blasting** High pressure water treatment – 9,000 to 10,000 psi. – should be done by experienced personnel. Lower pressure washing – 1,500 to 3,000 psi – may be suitable for removal of residue from self-dissipating curing compounds. **Grinding** Grinding can leave the surface smooth, and etching may be necessary to assure a mechanical bond. **Chemical** Should be done only by experienced personnel using nonflammable materials that are water cleanable and wax free. When this procedure is used, careful retesting is necessary. Always rinse thoroughly, allow to dry, and retest. In addition to the above procedures, some of which are suitable for vertical surfaces, lath may be installed.

TESTING

The water beading test is an effective method of indicating the presence of a curing compound or other contaminating material on a concrete surface. This simple test can be effectively performed by the tile installer:

Step 1:
Thoroughly sweep (clean) surface to be tested.

Step 2:
Visually survey area to identify potential problem areas.

Step 3:
Damp clean various areas on the slab and sprinkle with water droplets. If the droplets of water bead up and do not penetrate the slab within a few minutes, it is likely that the surface is contaminated, and the tile will not adhere.

Test Sample
Install several pieces of tile randomly in non-traffic areas. Allow to set at least three days, remove them to determine the adhesion to the slab.

Suggestion to the tile contractor:
The Curing Compounds, Form Release Agents, and Sweeping Compounds data is separate from Testing data so the tile contractor can copy page 24 and provide information needed by the contractor/builder without disclosing the tile contractor's test procedure.

This page is for the tile contractor's use only!

Date

Company
Address
City, State Zip

Re: Project
Substrate Conditions to Receive a Bonded Tile or Stone Installation.

Contact:

The success of the finished tile installation is directly related to the proper preparatory work done by other trades.

When tile or stone is to be bonded directly to a concrete slab, the following requirements are necessary:

1. Concrete slab must be sound, crack-free, and fully cured.
2. Concrete slab must be free of dirt, dust, oil, curing compounds, or any coatings that may prevent bond of the tile to the slab.
3. Concrete slabs to receive a thin-set tile installation shall have no variation in plane exceeding 1/4 in. in 10 ft. (6 mm in 3 m). Large format tiles (any side 15 in. [0.38 m] or longer) shall have no variation in plane exceeding 1/8 in. in 10 ft. (3 mm in 3 m).
4. Concrete slabs shall be steel troweled, then light broom finished.
5. Prior to commencing ceramic tile work, the surfaces to receive tile and accessories will be inspected. The architect or other designated authority will be notified in writing of any defects or conditions that will affect a successful tile installation. Installation work will proceed when satisfactory conditions are provided.

Concrete slabs that do not comply with industry requirements may be corrected by the use of the following procedures:

1. The removal of curing compounds, oil or other coatings can be accomplished by bush hammering, sandblasting, shot blasting, water blasting, chipping or scarifying to provide a substrate acceptable to receive tile and stone.
2. Slabs that are out of tolerance for the materials selected can be brought to standard by the use of cement-based flowable mortars or latex trowel-applied underlayments. Gypsum based underlayments are unacceptable without a full release of any liability to the tile/stone installer.
3. The ANSI A108 Standards and Specifications for the Installation of Ceramic Tile require that cracks in the substrate be treated with a crack-isolation membrane system to help avoid those cracks from telegraphing through the tile installation.

Name and Title
Company

Interior Horizontal Installation of Tile over Exterior Glue Plywood (EGP)

Introduction

The following is intended to offer possibilities for causes, characteristics of these causes, and prevention of certain problems related to interior installation of tile over exterior grade plywood. It is intended to be used with the proper judgment and experience of the individual craftsperson. The specific causes listed are common, but do not necessarily represent all problem areas. Installing tile over plywood presents special problems for the contractor since any failure of the wood floor system will appear as a tile-related failure. Awareness of the more common pitfalls and their results will help to prevent these mistakes.

TCNA Handbook methods F142 and F143.

1. The use of masonite, hardwood flooring, wood strip flooring, parquet flooring, composite panels, luan, fire-resistant or pressure-treated plywood, and wafer board are specifically unsuitable substrates/surfaces for the installation of tile.

2. Install tile only over plywood underlayment of grade C–C plugged exterior or plywood APA-rated Sturd-I-Floor Design Systems per APA Form E30.

3. Structure is to be designed to support the intended use of the floor system and finish materials. Subfloor minimum 19/32 in. (155 mm) EGP and underlayment minimum 19/32 in. (15.5 mm) EGP. Supporting structure is to be strong enough to limit deflection to 1 in. in 30 ft. (25mm in 9m); maximum allowable is L/360 system. Large-format tiles, particularly in large areas, may require a more rigid system.

4. Leave a gap between the tongue and groove EGP sheets of approximately 1/8 in. (3 mm). Also leave a gap at the perimeter of the room, not to be filled, but free to move slightly.

5. Plywood must be securely fastened to floor joist with 4D ring shank nails spaced 6 in. (152 mm) on center at edges of plywood and 8 in. (203 mm) on center at center of plywood sheets. Underlayment plywood should not be glued to the plywood subfloor. Offset joints in the subfloor from joints in the underlayment. Adjacent sheets of plywood should be within 1/32 in. (0.8 mm) of level.

6. Use of improperly installed tongue and groove plywood for subfloors and/or underlayment to receive ceramic tile may contribute to cracked tile outlining the plywood sheets due to expansion and contraction.

7. Any shrinkage of plywood occurring AFTER the installation of tile may damage the tile.

8. Plywood is not a suitable subsurface for the installation of ceramic tile where plywood is exposed to excessive moisture or humidity, such as steamrooms, gang showers, Roman tubs and pools, etc.

Install tile only over plywood underlayment of grade C–C plugged exterior or plywood APA-rated Sturd-I-Floor Design Systems per APA Form E30.

Interior Installation of Tile over Exterior Glue Plywood (EGP)

Problem	Cause	Cure
Expansion and contraction of plywood.	Plywood installed with grain parallel to joists. Moisture changes or high levels of moisture in wood.	Turn top sheet perpendicular to floor joists because greater shrinkage occurs perpendicular to grain. Offset joints of subfloor and underlayment. Allow 1/4 in. (6 mm) perimeter joints that will not be filled with setting materials.
Tile not in true plane.	Excessive variation of thickness between plywood sheets. Floor joists out of plane. Beat-in not adequate (see "Proper Bedding Procedures" on page 116).	Follow proper fastening procedure. Sand sheets thoroughly to level them. Use appropriate flowable/leveling underlayment material.
Tile cracks at perimeter of plywood sheets.	Tongue and groove plywood used. Gap not left between sheets. Excessive deflection due to joists in excess of 16 in. (406 mm) on center. Plywood not fastened sufficiently. Certain surfacing materials such as marble may require different installation systems or subfloor preparation.	Don't use tongue and groove plywood as the underlayment. When tongue and groove plywood is already installed as an underlayment, saw cut through to the depth of the bottom of the tongue. When height will not allow for overlay of another sheet of plywood or backerboard, the application of a crack suppression elastomeric membrane system may prevent cracks transferring to the ceramic tile.
Floor buckles.	Gap not left between sheets. Expansion and contraction of plywood due to moisture exposure. Shrinkage or warpage of joists or supporting structure. Excessive deflection due to joist spacing in excess of 16 in. (406 mm) on center or joist span may be too great. Girders/floor joists not properly fastened. For latex mortar/grout installations follow the bonding materials manufacturer's recommendation for treatment of joints between sheets.	Space required between sheets: 1/8 in. (3 mm) for organic adhesives (*TCNA Handbook* method F142); 1/4 in. (6 mm) for epoxy mortar (*TCNA Handbook* method F143). Follow bonding materials manufacturer's recommendations for treatment of joints between sheets. Protect and properly store plywood in a dry area. Proper vapor barrier in place. Proper ventilation. Joists and supporting structure should be dry (and conditioned to use level) before application of tile.

Interior installation of tile over exterior glue plywood

Problem	Cause	Cure
(continued from previous page) Arched or humped floor surface. Tile and/or grout cracked. Loose or broken tile. Springy floor.	*(continued from previous page)* Delaminated plywood. Improper nailing (fastening). Excessive deflection due to joists in excess of 16 in. (406 mm) on center; girders/floor joists not properly fastened. Expansion and contraction of plywood due to moisture exposure. Insufficient thickness of floor. Wood floor construction consists of only a single layer of plywood. Inadequate expansion joints.	*(continued from previous page)* Use only exterior grade plywood. Install according to *TCNA Handbook*, ANSI A108 Standards and Specifications and APA Form E30. Proper nailing helps restrain the plywood in shrinkage – expansion. Protect and properly store plywood in a dry area. After plywood is installed it should be protected from rain and moisture. Joists, underlayment, and supporting structure should be thoroughly dry before application of tile. Maintain 16 in. (406 mm) on center joist spacing. Use joists designed to support live and dead load. Use joists of larger size or move spacing to less than 16 in. (406 mm) on center. Securely fastening plywood on joists 16 in. (406 mm) on center provides joist support, stiffening the floor and limiting expansion and contraction.
Bonding failure.	Fire rated plywood or concrete form plywood used in floor construction. Improper setting material and/or installation procedures. Improper substrate or underlayment (see also other causes under "Thin Bed Installation Chapter" starting on page 111).	C–C (plugged) exterior grade plywood is a suitable material. C–D grade (sheathing) is not acceptable. Use a bonding material recommended and warranted by the manufacturer. See page 28.

Photo courtesy of Daltile.

Movement Joints

Control, contraction, and expansion provisions are necessary in all construction to accommodate expansion and contraction movement of building materials that will inevitably occur. It is important that proper movement provisions be designed into the structure as well as tile assembly.

The design and location of movement joint provisions must take into consideration the entire building movements and each building material's unique movement and resistance to movement characteristics.

Substrate movement, restraints to movement, temperature fluctuations, freeze/thaw conditions, and deflection are some of the factors that must be accommodated in the placement of movement joints related to tile installations.

The tile industry, through ANSI A108.01 and A108.02 and the *TCNA Handbook*, has taken steps to assist architects and engineers in providing movement provisions for tile installations.

The general recommendations of these publications have often been used by reference to transfer the responsibility of movement accommodation to the tile contractor, however, only the architect/engineer has adequate knowledge to design the movement system for a particular building.

Although the statement, "The Architect must specify expansion joints and show location and detail on drawing," appears in each of these publications, the expense of the resulting problems often is forced upon the tile contractor, as the tile contractor does have an obligation to advise or request clarification on the omission/absence of such information from the design professional.

Some architect/engineers have attempted to require the tile contractor to absorb the cost of movement provision when the omission was brought to their attention. In many instances the tile contractor has been held responsible for the cost of problems resulting from inadequate or no movement provisions.

WHAT THE TILE CONTRACTOR SHOULD KNOW

The recommendations of ANSI A108.01, ANSI A108.02 and the *TCNA Handbook* are intended to provide assistance to the architect/engineer in designing a movement accommodation system for tile installations.

The *TCNA Handbook* has now clarified that intent with the following statements, "It is not the intent of this guide to make expansion joint recommendations for a specific project" and "Architects, builder, or design professional must specify movement joints and show location and details on drawings." ANSI A108.01-3.7.1 also states, "It is not the intent of these specifications to make movement joint recommendations for specific projects. Specifier shall specify and detail movement joints and show locations."

Photo courtesy of Custom Building Products

Movement Accommodation

As the leading association representing installation companies in the United States for ceramic and natural stone tile, the National Tile Contractors Association actively participates in the development of standards and methods to improve the quality of workmanship and performance in both commercial and residential applications. We urge all of our contractor members to follow these standards and methods to ensure quality installations on their projects.

One of the most important standards our industry recommends to be followed is EJ171, allowing for movement accommodation in tile assemblies. EJ171 is recognized by the entire tile industry and can be found in the *TCNA Handbook*. Failure to account for movement in a tile or stone assembly is considered to be one of the leading causes of installation failure. This applies to both commercial and residential applications. By not accounting for anticipated movement in a ceramic or stone tile assembly, you run the risk of many problems with the installation, such as grout cracking, loss of bond of mortar to the tile, and in some instances, lifting or "tenting" of the tile as pressure pushes onto the material toward the center of the room.

Because of the limitless conditions and structural systems on which ceramic and stone tile can be installed, the architect or designer shall show the specific locations and details of movement joints on project drawings. The tile and stone industry recommends that movement joints be installed every 20-25 ft. (6.1 m - 7.6 m) in each direction in interior applications, and every 8-12 ft. (2.4 m - 3.7 m) in each direction on exterior projects. If interior jobs are exposed to direct sunlight or moisture, it should be treated as an exterior project and have movement joints every 8-12 ft. (2.4 m - 3.7 m) in each direction.

The NTCA feels very strongly that it is not the responsibility of the tile contractor to decide where to locate movement joints in the installation. However, it is a tile contractor's responsibility to make all parties aware of Method EJ171 and to not take on liability by proceeding with work that does not address movement accommodation and expansion joint placement and location.

Photo courtesy of Custom Building Products

Movement Accommodation Control Joints – Notes/Letter

NOTES TO THE TILE CONTRACTOR

Example letter should be modified to accommodate your specific circumstances. For example, there may be some control provided which you may wish to acknowledge.

Date

General Contractor
Address
City, State Zip

Re: Project

Contact:

Please note that expansion/movement/control joints have not been provided in the tile installation.

I have enclosed copies of the *Tile Council of North America's (TCNA) Handbook for Ceramic, Glass, and Stone Tile Installations,* which addresses expansion joints.

Please ask the responsible party to review the structural and tile installation specifications for the required provisions.

Once you have the control joint requirements specified and detailed, I will submit a price for their inclusion.

Sincerely,

Name and Title
Company

Enc.

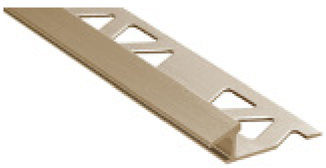
Profiles

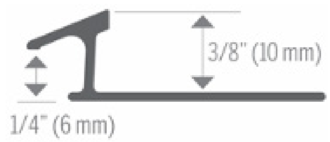
With tile manufacturers trending away from making trim units (including, but not limited to, bullnose), paired with the many shapes, sizes, and material types in the marketplace, it has been challenging to address the area where tile terminates or transitions on both floors and walls. Fortunately, innovative manufacturers have addressed this with profiles made from various alloys and plastics that maintain both function and pleasing aesthetics. Profiles should be seen as adding value to the tile project.

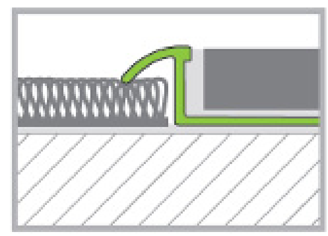
Profiles, while not new to the market, have seen wider use in recent years and now can be found on almost every tile project. With this increased acceptance and the complexity of tile projects, questions and concerns within the industry have arisen around the proper application, fitting, and usage of profiles.

Below as a point of reference, are some of the most common profiles and where they are used.

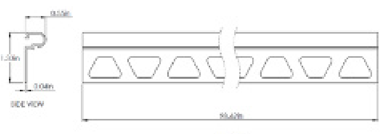
TRANSITIONS

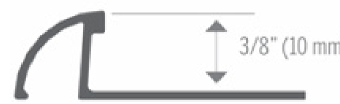


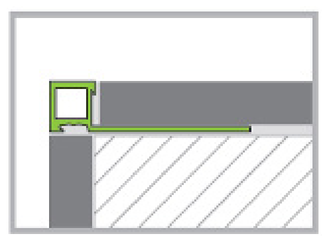




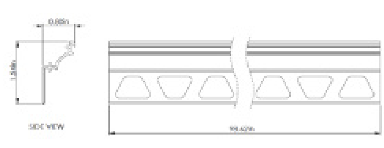
EDGE PROTECTION







COVE SHAPED



The above profiles do not take place of *TCNA Handbook* EJ171, which provides guidelines for the placement of movement joints. It is imperative to consult the profile manufacturer for specific details about each profile and to determine which profile is best suited for the desired application.

Profile Issues for Tile & Stone Installations

Problem	Cause	Cure
Lippage between profile and adjacent flooring	Tile warpage Floor flatness, wall flatness / plumb deviations Bow and/or twist of profile Incorrect tile installation method Incorrect profile size/depth/height	Ensure that all tile and floor flatness are within industry guidelines In situ mock ups are suggested to ensure appropriate expectations for customers Install on flat and even substrate Profile should be flush or up to 1/32 in. (0.8 mm) lower than the tile per manufacturer's literature Attend educational tile seminar for more tips Follow manufacturer's installation instructions
Tile cracking parallel to profile	Inadequate embedment of profile in tile assembly	Install profile and tile with sufficient mortar to create "sandwich" to fully support profile anchoring leg and tile Follow manufacturer's installation instructions
Etching and staining	Extended dwell time of thin-set/grout on profile Dirty cleaning water Allowing cleaning water to remain on profile See problem: "Profile unsuitable for application"	Remove mortar or grout residue from visible surfaces immediately Take particular care with epoxy adhesives and grouts Use fresh water to clean profiles End user should clean profiles periodically - consult manufacturer's instructions for cleaning and maintenance info

Problem	Prevention	Cure
Discoloration of profile when cutting Rough/bad cut	Do not install. Resolve cutting issue and remake piece Wrong speed used to cut profile Incorrect cutting tool/method	Use manufacturer recommended blades/tools Stainless Steel*: • Variable-speed angle grinder set to the lowest speed, using appropriate cutting wheel • Band saw with metal cutting blade Aluminum*: • Hacksaw with bimetal blade and the highest teeth per inch (TPI) available • Variable-speed angle grinder set to the lowest speed, using appropriate cutting wheel • Chop saw or miter saw with a nonferrous blade Brass*: • Hacksaw with bimetal blade and the highest teeth per inch (TPI) available • Chop saw or miter saw with nonferrous blade **Remove any burs after cutting profile using a file or other appropriate tool* PVC: • Straight snips with a sharp blade • Hacksaw with appropriate blade
Profile and corner/endcap misalignment	Not using connectors Connector size differential from profile (fit and finish) Installation method	Consider if connectors would be beneficial and verify size Use Shim, tape and/or silicone, as needed - Allow to cure prior to removal of shim, tape, or silicone Cut adjoining profile to correct length
Profile unsuitable for application; Wrong size (fit of leg/tile) Profile Shape inadequate for purpose Profile material unsuitable for application (e.g., plastic for hi-impact applications)	Uninformed specification	Check data sheet for material properties and areas of application Request sample pieces Create mock-up Consult product manufacturer representative Consult contractor Consult with specifier/architect

Questionable/Unsuitable Substrates

UNSUITABLE SUBSTRATES

Unsuitable substrates are substrate types that are not suitable to receive direct bond applications of ceramic tile and stone under any circumstances. The following are examples of unsuitable substrate types:

- Masonite
- All grades of luan plywood
- Any untreated polystyrene insulation boards without tileable surface coatings
- Extruded polystyrene insulation board
- Particle board
- Paneling
- Stripwood floors
- Hardwood floors
- Grease saturated concrete
- Contaminated concrete
- Cushion backed vinyl flooring
- Paper and glass mat exterior gypsum sheathing
- Pressure treated plywood
- Fire-resistant plywood
- Chemically treated plywood
- Felt paper
- Scribing felt
- Substrates that exceed recommended deflection under design loads
- Curing compound treated concrete*
- Form release treated concrete or masonry surfaces*

* Mechanical abrasion (e.g. shot blasting, high pressure water blast, sand blasting, etc.) is required to bring these substrate types into conformance with industry standards. See page 26.

* Certain unsuitable substrate types can receive ceramic tile and stone installations when installed with a non-bonded thick-bed mortar floor assembly or a cleavage membrane/lath and plaster wall assembly. Consult tile and stone installation manufacturers for their recommendations.

QUESTIONABLE SUBSTRATES

Questionable substrates are substrate types that when properly designed and prepared can receive direct bond applications of ceramic tile and stone. Some questionable substrates conform to specific ceramic tile and stone industry installation methodology when applicable requirements are followed. In addition, the use of specific installation materials designed for unique applications can result in a successful installation. Consult ceramic tile and stone installation manufacturers for their recommendations. The following are examples of questionable substrate types:

- Cutback or other adhesives
- Paint
- Metal
- Plastic laminates
- Epoxy coatings
- Seamless flooring
- Non-cushioned vinyl flooring
- Vinyl tile
- Chemically treated concrete
- Chemically hardened concrete
- Pre-cast concrete
- Post-tensioned concrete
- Grease-coated concrete
- Light-weight concrete
- Cork
- CDX plywood
- Gypsum concrete
- Gypsum plaster
- Poured-gypsum underlayment
- Tileable access panels
- Cracked concrete

Certain questionable substrate types can receive ceramic tile and stone installations when installed with a non-bonded thick-bed mortar floor assembly or a cleavage membrane/lath and plaster wall assembly. Consult ceramic tile and stone installation manufacturers for their recommendations.

Photo courtesy of Footprint Wood & Stone

Substrates/Applications that Require Design Consideration

THE FOLLOWING ARE EXAMPLES OF SUBSTRATES/APPLICATION TYPES THAT REQUIRE SPECIFIC DESIGN CONSIDERATIONS:

Exterior installations over steel or wood framing
- Suitable backer board
- Exterior rated sheathing and cement backer board
- Lath and plaster systems

Steam room applications over steel framing
- Suitable backer board
- Lath and plaster systems
- Thin tile installation over existing tile

INSTALLATIONS MADE OVER THE ABOVE CONSTRUCT TYPES (NOT LIMITED TO) THE FOLLOWING DESIGN CONSIDERATIONS:

- Framing deflection criteria
- Framing gauge – 20 gauge (0.039”) (0.033”) (0.84 mm) or heavier
- Frame spacing
- Frame depth
- Wind loads
- Creep
- Air barrier requirement/Placement/Location
- Water resistive barrier requirement/Placement/Location
- Insulation requirement/Placement/Location
- Exterior rated sheathing requirement/Placement
- Cement backer board/Exterior rated sheathing board edge bracing
- Lateral bracing for framing
- Purling
- Battens
- Fastener pattern
- Fastener type (Non-corrosive and non-oxidizing
- Taping of board seams with appropriate latex fortified Portland cement based mortar
- Use of appropriate exterior rated alkali resistant fiber mesh tape (4-in. [102 mm] width)
- Use of appropriate cement backer board type for application
- Use of appropriate wire lath type/Gauge for application
- Use/selection of appropriate latex fortified Portland cement based scratch and brown coat materials
- Waterproofing and/or vapor retarding membrane requirement/Detailing/Sequencing/Integration with other building elements
- Flashing requirements/sequencing/Detailing/Integration with other building elements
- Compliance with International Building Code/International Residential Code (applicable version) requirements
- Suitability of finish material for the application
- Suitability of installation materials for the application
- Dew point control
- Design/Placement/Construct of movement joints
- Consideration for particular climatic conditions and exposure

NOTE: The above items are design related and must be considered by the Project Design Professional when designing and specifying the ceramic tile and stone installation system in these applications. Consult ceramic tile and stone installation manufacturers for their recommendations.

Backer Board Definitions

Cement Backer Board
A backer board designed for use on floors, walls, and ceilings in wet or dry areas, this board is applied directly to wood or metal wall studs or over wood subfloors – referred to in ANSI as Cementitious Backer Units (CBU). Ceramic tile can be bonded to it with dry-set, latex/polymer modified Portland cement mortar, or epoxy by following the backer board manufacturer's instructions. It can also be used for glass and stone installations. Complete interior installation and material specifications are contained in ANSI A108.11 and ANSI A118.9 or ASTM C1325.

Coated Glass Mat Water-Resistant Gypsum Backer Board
A backer board conforming to ASTM C1178. Designed for use on floors, walls, and ceilings in wet or dry areas, this board is applied directly to wood or metal wall studs or over wood subfloors. Ceramic tile can be bonded to it with latex/polymer modified Portland cement mortar or epoxy by following the backer board manufacturer's instructions. It can also be used for glass and stone installations.

Glass Mat Water-Resistant Gypsum Backer Board
A backer board conforming to ASTM C1658. Designed for use on walls and ceilings in dry areas. This board is applied directly to wood or metal studs and ceiling framing. Ceramic tile can be bonded to it with dry-set, latex/polymer modified Portland cement mortar, organic adhesive, or epoxy by following the manufacturer's instructions. It can also be used for glass and stone installations.

Fiber-Cement Backer Board
A dispersed fiber-reinforced cement backer board designed for use on floors, walls, and ceilings in wet or dry areas, this board is applied directly to wood or metal wall studs or over wood subfloors. Ceramic tile can be bonded to it with latex/polymer modified Portland cement mortar, organic adhesive, or epoxy by following the backer board manufacturer's instructions. It can also be used for glass and stone installations. General interior installation and material specifications are contained in ANSI A108.11 and ASTM C1288. Consult the manufacturer's written literature for specific application details.

Fiber-Reinforced Water-Resistant Gypsum Backer Board
A backer board conforming to ASTM C1278. Designed for use on floors, walls, and ceilings in dry or wet areas, this board is applied directly to wood or metal wall studs or over wood subfloors. Ceramic tile can be bonded to it with latex/polymer modified Portland cement mortar, organic adhesive, or epoxy by following the backer board manufacturer's instructions. It can also be used for glass and stone installations.

Cementitious Coated Extruded Foam Backer Board
A waterproof backer board constructed from extruded polystyrene and coated with a cementitious coating, designed as a substrate for ceramic tile and stone in wet and dry areas. Designed for use on floors, walls, and ceilings in dry or wet areas, this board is applied directly to wood or metal wall studs or over wood subfloors. Ceramic tile can be bonded to it with dry-set, latex/ polymer modified Portland cement mortar, or epoxy by following the backer board manufacturer's instructions. It can also be used for glass and stone installations. Material specifications are contained in ASTM C578 and ASTM D4068.

Direct Bond to Wood or Gypsum Wall Board – Caution
Wood-based panels such as particle board, composite panels (veneer faces bonded to reconstituted wood cores), non-veneer panels (wafer board, oriented strand board [OSB], and other similar boards), luan plywood, and softwood plywood expand and contract with changes in moisture content and are not recommended as backing materials for direct bonding of ceramic tile. Plywood manufactured with fully waterproof adhesive and with an exposure durability rating of Exposure 1 or Exterior may be used on residential horizontal surfaces when installed in accordance with ANSI A108.01-3.4.

Gypsum wall board, including water-resistant gypsum backing board, may not be used as a backing for direct application of tile in intermittent wet or wet areas.

Source: "Backer Board Selection Guide," in *TCNA Handbook for Ceramic, Glass, and Stone Tile Installation*, p. 21. Anderson, SC: Tile Council of North America, 2012.

Backer Boards

Problem	Cause	Cure
Rust colored stains coming through the grout.	Non-corrosion resistant fasteners used when installing the backerboard.	Use only corrosion-resistant fasteners, or those specifically recommended by the manufacturer.
On vertical surfaces, the tile is cracked along the seams of the backerboard.	A. Backerboard seams not properly taped.	A. Using an alkali-resistant fiberglass tape, properly tape all seams of the backerboard. Prior to applying the tape, pack the seams with a dry set or latex-Portland cement mortar, or the specific setting material recommended by the backerboard manufacturer. Using a flat trowel, strike the setting material over the top of the tape leaving a smooth surface. Note: the use of drywall tape or drywall compound is strictly prohibited for taping backer board seams. Movement gaps or flexible joint sealants might be required by manufacturers.
	B. Fastener spacing and patterns not followed per the recommendation of the backer board manufacturer.	B. Follow the fastener spacing and patterns recommended by the backer board manufacturer.
White grout and/or tile yellowing.	Organic adhesive used to install tile over backer board installed in a wet area. **Note: Cement backer board will wick moisture when used in wet areas and will remain wet. Organic adhesives are not recommended in areas continually exposed to moisture.**	Use a dry set or latex Portland cement mortar when installing the tile.
Tile bond failure.	Using a setting material that is not recommended for the specific type of backer board and/or tile. Not wiping down the surface to remove dust and/or add moisture to the backerboard when required. Coverage does not meet requirements of ANSI A108.5	Consult the backer board manufacturer for the specific adhesive recommendation.
Irregular wall surfaces, bowed out at fixtures/grab bar locations.	Metal straps are installed over studs to provide support for wall hung fixtures, grab bars, etc.	Install supports between studs flush to face of studs to provide a suitable substrate to cover with tile. Option: When straps are installed over the face of studs, shim the remainder of all studs on the wall prior to the installation of backer board to provide a suitable substrate to cover with tile.

Problem	Cause	Cure
On horizontal surfaces, the tile is cracked along the seams of the subfloor or the underlayment.	A. The subfloor is inadequate to handle the static and dynamic loads being applied. B. Backer board seams not properly taped. C. Fastener spacing and patterns not followed per the recommendation of the backer board manufacturer. D. Subfloor deflection E. Proper spacing between sheets of subfloor not maintained according to manufacturer's directions.	A. Ensure that the subfloor is adequate to handle the static and dynamic loads expected. B. Properly tape all of the seams in the backerboard if required by manufacturer. C. Follow the fastener spacing and patterns recommended by the backer board manufacturer.
On horizontal surfaces, the tile/grout is cracking and the floor sounds hollow.	A. No leveling bed underneath the backerboard. B. Fastener spacing and patterns not followed per the recommendation of the backer board manufacturer.	Remove and correctly install the backerboard: properly laid out, spaced, set in a setting bed and fastened with appropriate fasteners following the manufacturer's fastening pattern. Fill and tape joints using alkali resistant mesh tape and the dry-set, thin-set adhesive being used to install the tile.

Photo courtesy of NTCA

Tile and Stone Applications on Equivalent Gauge (EQ) Steel Framing

– For Informational Purposes Only –

Though relatively new to the U.S. market in comparison to conventional flat steel studs, Equivalent Gauge (EQ) studs account for nearly 90 percent of drywall studs manufactured today and have largely displaced conventional nonstructural steel framing members in distribution.

Ranging from a base metal thickness of 0.019 in. to 0.024 in. (0.5 mm to 0.6 mm), EQ Studs are lighter and thinner than the 20 gauge drywall (0.030 in [0.77 mm]) and 20 gauge structural (0.032 in. [0.84 mm]) studs that traditionally have been used behind tile and stone installations, but in some cases may still meet the demanding requirements of these systems.

WHAT IS AN EQ STUD?
ASTM C645, the code-referenced standard governing nonstructural steel framing members, sets a minimum base metal thickness of 0.0179 in. (0.77 mm) (4.3). However, section 9.2 of the standard also allows the use of studs fabricated with thinner materials if it meets the performance requirements in the ASTM standard for nonbearing interior walls with gypsum panels (AC86) and conforms to the limiting height tables in ASTM C754. In order for a stud that is thinner than the proscribed C645 minimum to be allowed it must have a bending moment – or point where the stud buckles – that is equivalent or greater than its traditional counterpart. Manufacturers must provide sufficient data to enable calculation of design performance.

Equivalent Gauge (EQ) studs utilize a combination of manufacturing technology and steel chemistry to achieve these necessary results:

- Reinforcing ribs are added to the web and flange of the studs to increase the stiffness.
- High strength steel, typically twice the minimum of 33 ksi (230 MPa), delivers higher tensile strength at a lower weight.

Although EQ studs are relatively new to the U.S., one or both of these techniques have been used for decades to manufacture cold-formed steel framing in countries around the world.

Industry association code compliance certification programs, such as that managed by the Steel Framing Industry association, also impose additional requirements on EQ stud manufacturers. For example, all SFIA certified products must have:

- Published composite limiting heights tables in accordance with ICC-ES AC86-10
- Published screw data (shear and pullout) and must pass the screw spin out performance test in ASTM C645
- Must meet the corrosion protection requirements of ASTM C645.

Current *TCNA Handbook* methods state that tile and stone must be installed over conventional 20 gauge structural (0.0329 in. [0.84 mm] metal thickness) metal studs. In addition, 20 gauge drywall studs (0.030 in. [0.77 mm] metal thickness) studs were frequently used in place of the structural studs because of availability and potentially lack of knowledge by the installer. Both studs have performed satisfactorily over the years.

As an alternate path, a simple performance standard can also be used by the design professional and framing contractor to achieve the same result. Provisions include:

1. The wall framing should meet a deflection limit of L/360 for the rated load based on the properties of the stud alone.
2. The wall studs must be adequately braced by cladding or lateral bridging to resist the applied loads and meet the applicable code(s).
3. The framing members must have a G60 or equivalent coating.
4. The framing members must pass all the fastener requirements (spinout and pullout strength) of the applicable wall stud standard.
5. Use of appropriate equipment with proper type and placement of fastener.

RECOMMENDATIONS FOR THE TILE CONTRACTOR:
It is the responsibility of the design professional and framing contractor to ensure that wall assemblies for tile and stone finishes are designed and assembled to meet performance requirements, and all manufacturers of EQ studs will have the technical data needed for design and confirmation of performance requirements.

If so desired, the Tile Contractor can also perform several simple checks to further verify that the backer system will perform as required:

- Industry non-composite limiting heights tables can be consulted for allowable wall heights using conventional and EQ studs in designs based on the L/360 deflection limit. Note that products made by various manufacturers will have wall height tables for their products that will differ from product to product.
- The manufacturer must certify or provide evidence that the specified EQ studs pass all the fastener requirements (spinout and pullout strength) of the applicable wall stud standard.
- The Gypsum Board Manufacturer may also provide verification that it is acceptable to use their product(s) with EQ studs, along with any conditions for acceptance.
- All tile and stone installations, whether installed over conventional thickness framing or EQ framing, must be properly braced by cladding or mechanical bridging in order to meet strength requirements.
- Damaged framing members, whether standard or EQ products, should never be used.

Two additional courses of action are also available to the Tile Contractor:

- Request letter from framer that the requirements of ANSI 108.11 and/or performance standard of the *TCNA Handbook* method referenced has been used to meet the performance criteria; or
- Create letter from contractor stating that if improper framing was installed, tile contractor is not responsible for failures.

Tile Over Steel Stud Assembly – Letter

SAMPLE LETTER FOR TILE CONTRACTOR

Date

General Contractor
Address
City, State Zip

RE: Project

Contact:

We are installing tile on this project over a steel stud assembly that has been erected by others. Under ANSI A108.02.-4.1 General requirements "Prior to commencing ceramic tile work, the tile contractor shall inspect surfaces to receive tile and accessories, and shall notify the architect, general contractor, and other designated authority in writing of any visually obvious defects or conditions that will prevent a satisfactory tile installation. Installation work shall not proceed until satisfactory conditions are provided."

It is not within the knowledge or scope of work of the tile contractor to verify that the steel framing assembly is adequate to accept the specified tile and installation materials, the wall system is expected to meet the criteria:

- The wall framing meets a deflection limit of L/360 based on the properties of the stud alone
- The wall studs are adequately braced by lateral bridging to resist the applied loads and meet the applicable code(s)
- The framing members have a G60 or equivalent coating
- The framing members pass all the fastener requirements (spinout and pullout strength) of the applicable wall stud standard
- The appropriate procedures have been used for fasteners and placement

Name and Title
Company

General Statement on Deflection

– For Informational Purposes Only –

Deflection as it applies to the ceramic tile industry is the curvature induced by live and dead loads on the flooring structure of an elevated/suspended concrete slab or other substrates that will receive tile as a finish. The normal structural design criteria for allowable deflection is L/360 where L = the span in inches. These criteria must be met by the substrate prior to the underlayment or finishing material application. An example of how this measurement is used is as follows:

> If you have a suspended slab that measures 30 feet across with no intermediate supports, the "L" or length of the area is 360 inches. When this measurement is placed over the number 360, the result is 1 or 1" (360/360 =1). This means the slab or flooring structure can "deflect" or bend 1" without negatively impacting the structural integrity of the tile installation. If, for example, there was an intermediate support in the center of that same area, the "L" would measure 180; (180/360 = .5). The allowable deflection of this structure is now 1/2 in.
>
> The L/360 criterion applies to the full length of a room but it also applies to any segment within that room such as the span between floor joists in a wooden structure. This shorter span between joists is of great concern especially when the joist spacing is increased from the standard 12 in. or 16 in. spacing to 19.2 in. or 24 in. on center.

With this information in mind, we can say that deflection is the amount of vertical movement or curvature permitted by a substrate that will receive tile, and that this movement shall not exceed L/360.

> It should be noted that measuring deflection is very difficult and should not be calculated by the tile contractor. It is the design professional's responsibility to design a substrate that meets or exceeds the minimum stiffness criteria and to measure and evaluate deflection in actual assemblies.
>
> When installing stone tile and other tile, the level of permitted deflection is decreased to L/720 according to the Natural Stone Institute (NSI).

ANSI A108.01-2.3 Deflection
Floor Systems, including the framing system and subfloor panels, over which tile will be installed shall be in conformance with the IRC for residential applications, the IBC for commercial applications, *or applicable building codes.*

NOTE: The owner *should* communicate in writing to the project design professional and general contractor the intended use of the tile installation, in order to enable the project design professional and general contractor to make necessary allowances for the expected live load, concentrated loads, impact loads, and dead loads including weight of the tile and setting bed. The tile installer shall not be responsible for any floor framing or subfloor installation not compliant with *applicable building codes*, unless the tile installer or tile contractor designs and installs *the floor framing or subfloor.*

CALCULATION EXAMPLE:
L/360, where L = the span in inches.

On a suspended slab that measures 15 ft. across with no intermediate supports, (L) or length of span is 180 in. When the measurement (L) is placed over the number 360, the result is 0.5 (180/360=0.5). The deflection measurement therefore is 1/2 in. If a support were placed in the center of the span, (L) would be 90; (90/360-.25). That deflection measurement is 1/4 in. Typically, this measurement is made before the subfloor is installed on wood systems and on the concrete floor for concrete systems.

This is a very rudimentary example and other factors must be considered for an accurate calculation. For example, the tile industry references a 300 lb. concentrated load in its calculations. The criterion for measuring deflection is not a settled issue in the industry and you should always consult with your tile and setting material manufacturer for their specific deflection recommendations. When installing stone, refer to Natural Stone Institute (NSI) requirements regarding deflection.

Ceramic and Stone Tile Installations Over Engineered Wood Structural Floor Assemblies

– For Informational Purposes Only –

Design Professional Must Engineer System to Accept Tile Installation

SUMMARY OF I-JOISTS DESIGN AND CONSTRUCTION GUIDELINES FOR TILE INSTALLATION

- Engineered wood (EW) products must be properly stored (covered, off the ground) in accordance with manufacturer's instructions to prevent excessive moisture absorption. Avoid excessive concentrated loading of EW and all other wood framing after installation, especially if exposed to prolonged periods of rain.

- I-Joist design and selection must be based on realistic uniform dead loads (weight of materials) for a tile installation (especially if a thick mortar bed installation is proposed), as well as anticipated concentrated loads whenever possible.

- The maximum deflection of an I-Joist under ceramic tile floor finishes should be no greater than L/480 under live loads, and not the code required minimum of L/360. The Natural Stone Institute (NSI) recommends maximum deflection of L/720 under live loads for natural stone tile installations.

- If tile is to be installed in limited areas only (kitchen, bath, foyer), an increase in stiffness for the entire residence may not be necessary or economically feasible. It is more practical to decrease I-Joist spacing to 16 in. (406 mm) or 12 in. (305 mm) on center under those areas if possible. Offset the joints of the underlayment layer from the joints of the subfloor, utilize solid blocking between joists to both support subfloor panel edges and stiffen the subfloor panel (plywood or OSB) either as a preventative or corrective measure. Gluing the subfloor panels to the joists will increase the stiffness of the floor-panel system. Gluing the T&G of subfloor panel joints will increase floor stiffness even more.

- Follow manufacturer's required construction details for all floor-framing conditions to ensure specified performance of EW products (examples: solid blocking over support beams, load bearing web stiffeners where required, blocking near perimeter support walls, or use of "wet" design values to provide added safety factor.

- Provide bracing for the bottom flange of exposed I-Joists in unfinished basements with lateral wood bracing or metal bridging even if not required by the I-Joist manufacturer (required only for certain I-Joist depths/sizes) to protect from increased torsion and vibration common to I-Joists.

Photo courtesy of Dave Gobis

Summary of Subfloor (Plywood or OSB) Design and Construction Guidelines for Tile Installation

- Direct adhesion of tile to OSB has traditionally been prohibited by the tile industry. This is due to the potential for swelling during or after installation, as well as the lack of recovery upon drying, both of which have been proven to adversely affect tile adhesion. As with plywood, it is important that tile be installed only over those floors that are not subject to unusual wetting or humidity conditions.

- The traditional and proven wood subfloor thickness for tile installations on joists spaced 16 in. (406 mm) is two layers of 5/8 in. or 19/32 in. (15.5 mm) thick plywood. The deflection of this assembly over 16 in. (406 mm) joist spacing with uniform loads prescribed by building codes (10 psf [48.8 kg/m^2] dead load and 40 psf [195 kg/m^2] live load) is in the range of L/1000. The deflection in accordance with *TCNA Handbook* methods under a single 300-pound concentrated load in the center of one span is approximately L/400, assuming average quality plywood.

- Stiffness calculations show that two layers of 3/4 in. (19 mm) or 23/32 in. (18.5 mm) thick plywood over joists spaced 19.2 in (488 mm) on center will perform equivalently to the two layers of 5/8 in. or 19/32 in. (15.5 mm) thick plywood over joists spaced 16 in. (406 mm) on center. With joists spaced 24 in. (610 mm) on center, it takes two layers of 7/8 in. (22.5 mm) plywood or one layer of 1-1/8 in. (28.5 mm) plywood to provide equivalent performance. These calculations, however, do not take into consideration stiffening techniques such as lamination/attachment between layers of sub-floor and underlayment panels. Therefore, it is acceptable to comply with *TCNA Handbook* methods for sub-floor and underlayment recommendations for 19.2 in. (488 mm) and 24 in. (610 mm) I-Joist spacing.

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- Other generic or proprietary underlayments, including thicker proprietary plywood products manufactured for tile assemblies, or mortar beds and cement backer boards, may be substituted to achieve required equivalent stiffness, but the substitution underlayment or subfloor must be tested in accordance with Industry Standards.

- Subfloor panels (plywood and OSB) must be installed with the face grain or strength axis perpendicular (long dimension across) to the I-Joists to ensure proper strength. Subfloor panels must be both glued and attached with minimum 6d ring shank nails or screw fasteners. A 1/8 in. (3 mm) space must be provided between subfloor panels at both panel end and edge joints.

- The ends of the top layer of plywood (underlayment layer) should be installed with the joints over a support and offset at least one joist spacing from the end joint of the subfloor panels below. Underlayment joints located between supports will not provide maximum structural stiffness to the floor system.

The traditional and proven wood subfloor thickness for tile installations on joists spaced 16 in. (406 mm) is two layers of 5/8 in. or 19/32 in. (15.5 mm) thick plywood.

Technical Background – Engineered Wood Structural Floor Assemblies

– For Informational Purposes Only –

Engineered wood structural framing systems are now used in approximately 50% of new home construction in the U.S.

Engineered wood structural framing systems generally consist of wood I-Joists, and oriented strand board (OSB) sub-flooring. I-Joists were introduced in the 1960s and OSB about 1980. Since their introduction, there has been considerable controversy within the tile industry over technical considerations and limitations for installing tile over engineered wood products used in structural framing, sub-floor sheathing, and underlayments.

The primary issues are the longer span and spacing capabilities of engineered wood I-Joists, as well as the effects of moisture absorption on engineered wood products. The concern is that increased joist span, joist spacing, and susceptibility to dimensional and strength changes from prolonged moisture exposure results in a greater amount of floor movement and distress, which in turn may cause or contribute to cracking and adhesion failure of rigid tile floor finishes.

Engineered Wood Product Terminology

The term engineered wood (EW) products encompasses a wide variety of product types. EW products are manufactured by bonding wood strands, veneers, flakes, lumber or other forms of wood fiber to produce larger composite units with specific structural performance characteristics. These wood products may be used as individual structural components, or be further engineered as a component in different types of composite structural products.

There are four general categories of engineered wood products:

- Wood structural panels – used as the subfloor and/or underlayment in wood floor construction, this category includes softwood plywood, hardwood plywood, oriented strand board (OSB) and particleboard.

- I-Joists– typically composite assemblies composed of laminated lumber (LVL), solid, or finger-jointed lumber flanges and oriented strand board (OSB) webs.

- Structural composite lumber (SCL) – primarily laminated veneer lumber (LVL), parallel strand lumber, and oriented strand lumber that can be used as beams, joists, or the flanges of I-Joists.

- Glue laminated timber – also known as glulam, is composed of selected laminations of lumber glued face to face and primarily used in commercial construction.

TECHNICAL BACKGROUND INFORMATION

Increased I-Joist Span

The capabilities of engineered wood extend floor spans of the I-Joists well beyond those traditionally available in sawn, dimension-lumber frame construction. While the longer spans of I-Joists can result in a greater amount of floor deflection, it is not the increased spans and overall deflection that typically cause tile cracking and failure.

Applying the same deflection standard (L/360) as required of conventional dimension lumber framing, the longer I-Joist spans actually result in a larger radius of curvature under identical tile module sizes, therefore inducing less shear and flexural stress on the tile at the longer I-Joist spans. So while increased stiffness of I-Joists may be important, it is only one of several considerations for successful tile installations.

I-Joists are often specified using predetermined span tables or computer programs which may utilize dead load criteria that are not representative of the actual weight of modern tile floor assemblies. This is critical for those tile installations incorporating thick mortar beds, heavy dimension stone slabs, or underlayment products, which can significantly increase the deflection of the I-Joist under full design loads. I-Joists must be engineered to adequately resist the higher dead loads. This is especially true if the joists in these types of installations are to be installed at maximum spans using tables that assume only 10-psf dead load. Sound engineering practice would also require designing for various fixed, concentrated loads from permanent equipment or fixtures. A kitchen island with a stone slab counter weighing 1,600 pounds is typically considered a uniformly distributed load and may be within prescribed design load boundaries for the joists. A 1,600-pound piano supported on three small-diameter legs may not exceed the load capacity of the sub-floor panels or the I-Joists, but the curvature induced by the concentrated point loads may exceed the flexural strength of tile. While both conditions are considerably different, these conditions should be checked by a qualified engineer or architect.

It is important for the tile contractor to understand that the building-code-prescribed live-load deflection limit of L/360 is not the same L/360 that is required for ceramic tile installations as a minimum performance standard under tile floors. The floor that meets building code requirements typically meets or exceeds the capacity to resist a static (non-moving) uniform load distributed evenly over the floor. Tile flooring installations require that the tile floor system resist a dynamic (moving), 300-pound concentrated load.

As a comparison, a code-minimum floor panel spanning three joists spaced 16 in. (406 mm) on center (two spans) will deflect about 0.008 in. under a total load of a 40 psf, the code-prescribed minimum live-load capacity. A 300-pound point load, such as that from a hand-truck wheel or heel of a person carrying a large load, can produce a deflection of about 0.12 in. between the joists. Neither deflection is very much and is unlikely to be noticed by the occupants or the tile installer. The curvature induced by the concentrated load, however, is approximately 9 times that induced by the uniform load.

It's a bit ironic that the building codes traditionally prescribe an L/360 uniform live load deflection limit when a floor is almost never subjected to a uniform live load. The live loads imposed on a tile floor are generally the concentrated loads of various sizes, ranging from high heels and loaded hand-truck wheels to heavy furniture or fixtures.

Increased Joist Spacing and Deflection of Subfloor Panels

The spacing of I-Joists is one of three variables that must be balanced to satisfy the basic requirements of an engineered wood structure. The span and depth (size) of the I-Joists are the other variables. Increasing the spacing between joists is typically the prime consideration, as there is a tangible labor and material saving by eliminating one or two joists per 96 in. (2.4 m) length of subfloor panel. In reality, decreasing the joist depth, or increasing joist span while maintaining traditional joist spacing of 16 in. (406 mm) on center, may have equal but less tangible benefits.

The issue with joist spacing is the effect that increased joist spacing has on the stiffness and resulting curvature of the subfloor and underlayment between the joists. Conventional dimension lumber joists are typically spaced either on 16 in, (406 mm) or 12 in. (305 mm) centers because of the more limited bending capacity and stiffness of sawn lumber at maximum spans compared to EW I-Joists. Wood I-Joists introduced and popularized the concept of 19.2 in. (488 mm) and 24 in. (610 mm) on-center floor-joist spacing, primarily because of the increased structural load capacity and stiffness of these engineered wood products. The 19.2 in. (488 mm) and 24 in. (610 mm) spacings correlate with the modular length 96 in. (2.4 m) of typical subfloor panels, thus maximizing economy and performance by eliminating one or two joists per 96 in. (2.4 m) length of wood structural panel.

At the conventional floor-joist spacings, wood structural subfloor and underlayment panels are typically governed by bending strength, so curvature caused by deflection isn't as big an issue. With wider joist spacings, however, deflection is more frequently the governing factor and it can lead to greater curvature. It is the curvature that is likely the biggest structural source of tile failures.

Increased I-Joist spacing increases the curvature of the sub-floor panels, which in turn may induce excessive flexural and shear stress in a tile adhered to the subfloor. This is even more critical with today's larger 12x12 in. (305x305 mm) and greater tile modules, as some of the stress induced by the increased curvature can be absorbed by the softer and more frequent grout joints of smaller tile module installations across the same increased joist spacing. Similarly, while I-Joists have the capacity to support concentrated loads within the prescribed deflection criteria, the typical subfloor-panel thickness is not sufficiently stiff to support concentrated loads without excessive curvature.

Therefore, the stiffness and curvature of the subfloor panel are more critical than the span and deflection-related curvature of the I-Joists. When installing tile over the increased spacing and more vibration-prone I-Joists, it is recommended that the builder or tile contractor provide a subfloor panel, in combination with an underlayment panel, that has a greater stiffness than is required by minimum building code requirements. The *TCNA Handbook* methods provide recommendations for subfloor and underlayment panel construction to provide adequate stiffness to resist deflection at increased I-Joist spacing.

While a tile installation bonded directly to the subfloor, that utilizes a more flexible adhesive or a bonded flexible interlayer/membrane, will minimize the shear stress induced by increased deflection tile remains susceptible to cracking if the loads exceed the tile's flexural bending or breaking strength. A non-bonded tile installation that has the capability of distributing concentrated loads to the joists (full mortar bed), is much less susceptible to distress as long as the I-Joists are designed using realistic dead loads of the non-bonded mortar bed system.

Differential Deflection

EW I-Joists located adjacent to and parallel to an end wall or internal load-bearing wall have significantly different curvatures under load than those located over the continuous support of the rim joist or bearing wall. This is also true of sawn lumber joists.

Differential deflection, especially at longer I-Joist spans, may result in torsion due to the difference in deflection over a relatively short distance, adjacent to the perimeter support or internal support. It is advisable to compensate with framing details (stiffer joists, closer joist spacing, outriggers, or blocking).

Effects of Moisture on Engineered Wood Products

Exposure to moisture can affect the physical performance of all wood products, and engineered wood products are no exception. EW products, including plywood, generally have an equilibrium moisture content (MC) that is slightly lower than conventional sawn dimension lumber. I-Joists and OSB are manufactured with MC in the range of 4 to 6% and reach an equilibrium moisture content of about 10-12% in a typical home. Sawn lumber, on the other hand, may have an MC at installation of over 20% and then dry to 10-12%. The net effect is that engineered wood will gain moisture and size in most interior environments, while the moisture content and size of conventional sawn lumber will likely decrease in service.

Increased moisture content generally results in decreased strength and stiffness of all wood products. Repeated wetting-drying cycles may eventually produce permanent strength loss and deformation. Raising the moisture content of wood from normal equilibrium (11-12%) to fiber saturation of about 30% from prolonged moisture exposure can decrease stiffness by 15% (fiber saturation being the point at which there are no further dimensional or structural changes in wood).

Similarly, long-term-elevated moisture content (>15%) can have a significant effect on wood creep. Wood creep is similar to that of concrete creep, where the deflection due to dead-load deflection (weight of floor assembly and other permanent loads) can increase over time. Under normal conditions, creep in wood is approximately 50% of the initial dead-load deflection. Under elevated MC, deflection in OSB due to creep can triple. This means that if loads are applied for a considerable length of time while OSB remains damp, the result can be significantly greater deflection under loads, resulting in permanent deformation of the floor levelness.

In addition, the amount of load and the length of time that load is applied will influence the creep seen in the floor system. When panels will sustain permanent loads that will stress the product to one-half or more to its design strength capacity, allowance should be made for creep. If the moisture content is high (over about 16%), OSB will creep about three times as much as plywood. When dry, the creep is approximately equal in both plywood and OSB.

As the structural properties of I-Joists are based on dry-use design values, they are not recommended for use in continuous high-moisture environments such as indoor swimming pools. Continuously damp basements may also result in strength reduction of both I-Joists or conventional sawn lumber. Moisture content of all wood floor joists, sheathing and underlayment should be checked and verified as dry (at normal equilibrium state: typically 8-12%) and stable before the installation of tile finishes.
OSB subfloor panels respond to water vapor much like plywood subfloors. Upon initial exposure, OSB absorbs water more slowly than plywood. Exposure to liquid water can result in thickness swell in both plywood and OSB. Total swelling of OSB, however, can be greater than that of plywood; perhaps greater than 10-15%, and less than half of that increase in thickness will recover on drying. The large thickness swell is due to rebound from densification from the manufacturing process, which is released upon exposure to water.

Direct adhesion of tile to OSB has traditionally been prohibited by the tile industry. This is due to the potential for swelling during or after installation, as well as the lack of recovery upon drying, both of which have been proven to adversely affect tile adhesion. As with plywood, it is important that tile be installed only over those floors that are not subject to unusual wetting or humidity conditions.

When OSB is used as the web material in an I-Joist, the swelling of OSB from prolonged water exposure can result in decreased stiffness, due to relaxation of the compressed strands of wood. This is why I-Joist manufacturers strongly recommend that I-Joists be protected from the weather prior to installation.

OSB subfloor

General Contractor's Guide for Ceramic and Stone Tile Installations Over Engineered Wood Structural Floor Assemblies

MEMBER DESIGN

Truss or joist members are often designed or specified using predetermined span tables or computer programs that may utilize dead load criteria (normally 10 psf) that are not representative of the actual weight of modern tile floor assemblies. In some cases the framing, subfloor, and underlayment material are near the 10 psf assumption even before the weight of the tile installation is considered. It is critical that the design for strength and deflection (stiffness) of all structural components in a floor be based on realistic uniform dead loads (weight of materials) for a tile installation as well as anticipated concentrated loads whenever possible. Failure to evaluate all structural components to ensure that they will adequately resist the higher dead loads found in ceramic tile and stone installations can lead to potential problems with the installation due to excessive deflection and curvature. Dead load should include the weight of all materials that make up the tile installation, including the trusses or joists, subfloor, underlayment products, mortar bed, and the tile or stone. This is especially important for those tile installations incorporating thick mortar beds, heavy dimension stone slabs, or underlayment products. Concentrated loads that should be considered include permanent equipment or fixtures, such as a kitchen island, as well as heavy semi-permanent furnishings such as pianos and pool tables.

Designing for deflection has been confusing in the past, but in recent years the ANSI A108 committee on tile and the *TCNA Handbook* has adopted the following language to help clarify the requirements: "Floor systems, including the framing system and subfloor panels, over which tile will be installed shall be in conformance with the IRC for residential applications, the IBC for commercial applications, or applicable building codes." Keep in mind that these are **minimum** requirements and it is good practice to consult the material manufacturers for any more stringent criteria that they may recommend for use with their products.

TRUSS OR JOIST SPACING

The spacing of trusses or joists not only impacts the deflection of the floor parallel to (the span of) those members, but also impacts the deflection of the sub-floor spanning across the joints in the perpendicular direction. Deflection or curvature of the subfloor panels under loading (plywood or OSB) between trusses or joists is perhaps the biggest structural cause of tile failures since the typical code-minimum subfloor panel thicknesses are not sufficiently stiff to support concentrated loads without excessive deflection or curvature. As truss or joist spacing increases, the problem is magnified.

Many *TCNA Handbook* methods limit spacing to 16 inches on center for these reasons; however, options for wider on center spacings are available. *TCNA Handbook* method F149 requires the subfloor panels to be 23/32 in. (18 mm) exterior-glue tongue-and-groove panels meeting PS 1 or PS 2 criteria and the underlayment to be 19/32 in. (15.5 mm) exterior-glue plywood for joists spaced 24 in. (610 mm) on center. There are additional *TCNA Handbook* methods for 19.2 in. (488 mm) and 24 in. (610 mm) on center spacings with less stringent requirements for subfloor and underlayment panel thicknesses that incorporate crack suppression or uncoupling membranes to address the problems caused by excessive curvature. While these methods will help minimize the undesirable effects of increased curvature, the tile remains susceptible to cracking if the loads exceed the tile's flexural bending or breaking strength.

SUBFLOOR AND UNDERLAYMENT PANELS

Subfloor panels must be installed with the face grain or strength axis perpendicular to the support members (long dimension across supports) to ensure proper strength and maximum stiffness. **Subfloor panels must be glued/adhered and attached with the specified mechanical fasteners. A 1/8 in. (3 mm) space must be provided at time of panel installation between the panel edges and anything they abut such as perimeter walls, pipes, etc.

Underlayment panel ends should be staggered by at least one joist spacing from the ends of the subfloor panels and offset from the floor joist below by two inches so that underlayment end fasteners do not penetrate the joist. This helps to minimize the potential for "pops." Underlayment panel edges should be offset from the edges of subfloor panels at least two inches to minimize the potential for cracking over joints. The face grain of the underlayment panels should be oriented perpendicular to the supports. Underlayment panels must be installed with a 1/8 in. space between the panel edges and anything they abut such as perimeter walls, pipes, etc.

Some underlayment panels may be considered structural and their contribution may add to the stiffness of the floor-panel system. For example, the use of plywood as an underlayment panel will add stiffness to the floor when properly installed and is considered a suitable substrate for tile installation. However, other proprietary underlayments, while providing a suitable substrate for tile, may not be considered structural components and may not add any stiffness to the floor assembly. To be considered a structural component, the underlayment panel must be tested in accordance with industry standards, and in all cases, floor assemblies should be designed to conform to building code and the applicable details in the *TCNA Handbook*.

***Refer to project documents and wood and tile industry standards for specific installation instructions for subfloor and underlayment panels, for fastener type, diameter, length and spacing, and for the type of glue/adhesive required.*

EDUCING JOIST SPACING FOR TILE IN LIMITED AREAS

If tile is to be installed in limited areas only (kitchen, bath, foyer), an increase in stiffness for the entire residence may not be necessary or economically feasible. It may be more practical to decrease truss or joist spacing to 16 in. (406 mm) or 12 in. (305 mm) on center under those areas if possible. As required by building code, use tongue-and-groove subfloor panels or utilize solid blocking between members to both support subfloor panel edges and stiffen the subfloor panel either as a preventative or corrective measure.

DEFLECTION

Wood framed floor assemblies designed to receive a tile floor finish should have a maximum deflection as prescribed by building code and industry standards – including manufacturers' literature. **When installing stone tile, consult with The Natural Stone Institute (NSI) for recommendations on deflection.**

DIFFERENTIAL DEFLECTION

Joists located adjacent to and parallel to an end wall or internal load-bearing wall have significantly different curvatures under load than those located over the continuous support of the rim joists or bearing wall. Differential deflection, especially at longer spans, may result in excessive panel curvature due to the difference in deflection over a relatively short distance, adjacent to the perimeter support or internal support. It is advisable to compensate for the differential deflection in these areas with framing details (stiffer joists, closer joist spacing, outriggers, or blocking).

STORAGE

All wood products must be properly stored (covered, off the ground) in accordance with manufacturer's instructions to prevent excessive moisture absorption. Avoid excessive concentrated loading of wood framing after installation, especially if exposed to prolonged periods of rain.

I-JOIST CONSTRUCTION DETAILS

Follow the manufacturer's required construction details for all floor-framing conditions to ensure specified performance (examples: solid blocking over support beams, load bearing web stiffeners where required and blocking near perimeter support walls).

OSB

Direct adhesion of tile to OSB has traditionally been prohibited by the tile industry. This is due to the potential for swelling during or after installation, as well as the lack of recovery upon drying, both of which have been proven to adversely affect tile adhesion.

OSB should only be incorporated as the subfloor to receive some type of underlayment over it, provided the underlayment panel manufacturer will allow OSB to be used as a subfloor. In wood construction, it is important that tile be installed only over those floors that are not subject to unusual wetting or humidity conditions, such as improperly protected crawl spaces and basements.

Beams with joists.

Glossary of Terms for Engineered Wood Products

Blocking Panel – Cut from I-Joists, the blocking panel is placed between and perpendicular to the I-Joists. It functions to evenly distribute vertical loads from above when placed over load bearing walls, provides lateral support to keep I-Joists in a true vertical position, and also transfers lateral shear forces from the floor system into the supporting members below.

Cantilever – An unsupported overhang of joists extending beyond the load bearing support wall of a building. Joists should be supported laterally by blocking panels at the bearing wall nearest the cantilevered end to prevent rollover. In general, the cantilever length should be 1/4 of the adjacent span or more to prevent “humps” in the floor that may negatively affect your tile installation.

Flanges – The top and bottom rectangular components of an I-Joist that are either sawn lumber or structural composite lumber, such as laminated veneer lumber (LVL). The top flange is of the same type and grade of material as the bottom flange. The net flange size depends on the material used.

Glue Laminated Timber – also known as glulam, is composed of selected laminations of lumber glued face to face and primarily used in commercial construction.

I-Joists – An “I” shaped engineered wood structural member. I-Joists are prefabricated using sawn or structural composite lumber flanges and wood structural panel webs, bonded together with exterior-type adhesives. Due to their unique shape and geometry, they require specific construction details to perform properly.

Rim Board – A rectangular board ranging from 1 in. (25 mm) to 1-1/2 in. (38 mm) thick placed perpendicular to the I-Joists at the perimeter of the building. It functions to evenly distribute vertical loads from above when placed over load bearing walls, provides lateral support to keep I-Joists in a true vertical position, and also transfers lateral shear forces from the floor system into the supporting members below.

Rim Joist – Similar to Rim Board, an I-Joist can be placed perpendicular to the I-Joists at the perimeter of the building. It functions to evenly distribute vertical loads from above when placed over a load bearing wall, provides lateral support to keep I-Joists in a true vertical position, and also transfers lateral shear forces from the floor system into the supporting members below.

Squash Block – 2 in. x 4 in. (51 mm x 102 mm) or 2 in. x 6 in. (51 mm x 152 mm) lumber cut to a vertical length of the depth of the I-Joist plus 1/16 in. (2 mm) and placed adjacent to I-Joists beneath load bearing walls to transfer concentrated loads above to the load bearing wall below.

Structural Composite Lumber (SCL) – Rectangular sections produced by combining strands or veneers of wood together with exterior type adhesives. Common types are laminated veneer lumber (LVL), parallel strand lumber (PSL), and laminated strand lumber (LSL), which can be used as beams, joists, or the flanges of I-Joists.

Webs – The wood structural panel serving as the vertical center component of an I-Joist. Can be plywood or oriented strand board (OSB). All panels are classified as Exposure 1 or Exterior and are 3/8 in. (10 mm) in thickness or greater.

Web Stiffeners – A wood block that is used to reinforce the web along the vertical axis of an I-Joist where the web is in jeopardy of buckling out of plane or the web of the I-Joist is in jeopardy of knifing through the I-Joist flanges. There are two kinds of web stiffeners; bearing stiffeners and load stiffeners. They are differentiated by the applied load and the location of the gap between the slightly undersized stiffener and the top or bottom flange. Load stiffeners are located between supports where significant point loads are applied to the top flange of an I-Joist. The 1/8 in. (3 mm) gap is at the bottom flange of a load stiffener. Bearing stiffeners have the gap located adjacent to the top flange. They are used at supports where significant point loads exceed the joist’s bearing capacity. The bearing stiffener transfers load directly into the bottom flange and increases the joist’s bearing capacity.

Wood Structural Panels – Used as the subfloor and/or underlayment in wood floor construction, this category includes softwood plywood, hardwood plywood, oriented strand board (OSB) and particle board.

Knock-outs – A 1-1/2 in. (38 mm) diameter perforated hole located at equally spaced intervals along the web of an I-Joist. The knockout is intended to provide plumbers and electricians access holes for wiring or small diameter pipes without having to drill holes or check manufacturer’s literature to determine where holes can be placed. The knockout can be removed by lightly tapping the plug with a hammer.

NOTES TO THE TILE CONTRACTOR

Example letter should be modified to accommodate your specific circumstances.

Date

Company
Address
City, State Zip

Re: Project
Tile installations over wood sub floors

The specifications for this job call for the installation of (ceramic tile or stone). Over a framing system and subfloor panels built to applicable code requirements (considering the intended live and dead load) a system detailed in the *TCNA Handbook For Ceramic, Glass, and Stone Tile Installation (TCNA Handbook)* and recommended by all relevant manufacturers for this application must be installed. Systems in the *TCNA Handbook* are tested using ASTM C627 criteria which includes concentrated loads and are therefore subject to a more stringent requirement than flooring soft goods. All tile floor assemblies must comply with the corresponding applicable details as outlined in the *TCNA Handbook*, to ensure the tile installation will function properly. When installing stone tile, consult with the The Natural Stone Institute (NSI) for recommendations on defection.

It is the responsibility of the building owner to communicate in writing to the project design professional and general contractor the intended use of the tile installation, in order to enable the project design professional and general contractor to make necessary allowances for the expected live load, concentrated loads, impact loads, and dead loads including the weight of the tile and setting bed.

If you have any questions, please do not hesitate to contact me.

Name and Title
Company

Ceramic Tile and Stone Installations over Concrete Substrates

SUMMARY OF FLATNESS AND LEVELNESS REQUIREMENTS OF CONCRETE SUBSTRATE ISSUES

The installation of applied finishes on concrete floor surfaces requires different levels of flatness and levelness for success. This can be problematic when concrete floors are constructed to an incorrect tolerance or when unrestrained drying shrinkage curling is permitted to change the constructed “as-built” concrete floor tolerances to unacceptable levels.

Applied finish manufacturers often employ straightedge tolerances, which have proven to not be practical for concrete floor construction. The concrete floor trade utilizes a special tolerance system called F-Numbers, which relate the flatness (FF) and levelness (FL) of a concrete floor surface. Floor flatness and levelness tolerances are produced by the construction methodology employed and are therefore extremely practical. Using more advanced methods of construction, concrete floor flatness and levelness can be improved to meet any need (costs generally increasing with higher tolerance demands).

All jointed, non-continuously reinforced concrete floors on grade will change in surface profile as they dry. This process is called drying shrinkage curling. The influence of drying shrinkage curling of the concrete cannot be understated – this is a significant problem. Without sufficient restraining steel in the concrete, concrete floors will curl upwards at all joints. Without any steel reinforcing, concrete surfaces have been observed to curl more than 25mm at joint intersections.

The National Tile Contractors Association has published floor flatness tolerance recommendations of FF50 and FF60 for tiles larger than 16 in. (406 mm) or with narrow 1/8 in. (3 mm) joint sizes.

This document also includes tolerances of FF25 and FF32, which fall within the normal range of results for Class B methodology. Tolerances in excess of FF35 can only be achieved using deferred toppings and the most advanced methods of construction. This is not practical.

Curling and other flatness variations are design and construction issues. Resolve these issues **before** the bid by involving the design professional, general contractor, concrete contractor, and flooring installer. Tradeoffs are inevitable. The least expensive design choice may not produce the best results.

RECOMMENDATIONS:

Specifiers must exercise great care when determining concrete floor tolerances.

Specifiers must design concrete floors to retain the as-built concrete floor tolerances with sufficient restraining reinforcing steel.

Concrete floor tolerances for applied finishes must be discussed and reviewed carefully at pre-construction meetings. Concrete materials for slabs on grade must be designed to reduce drying shrinkage while remaining workable and finishable.

Tolerance losses due to the drying shrinkage curling are a design matter and are not the responsibility of either the concrete floor or tile trade contractor.

Concrete floor tolerances of FF50 and FF60 are not a practical solution. Tile contractors who wish to obtain surface tolerances in excess of Class B (FF25-35) will need to include allowances to level the floor with a grout bed to suit their needs.

TECHNICAL BACKGROUND INFORMATION

CSA A23.1 defines two classifications for conventional surfaces: Class A (FF20) and Class B (FF25). Class A surface tolerances are suitable for most concrete floors subject to foot traffic and thick finishes. Class B tolerances may be employed when enhanced surface flatness is desired or required. Class B tolerances are the upper limit of practical tolerances for most residential, commercial and institutional floors. Note that Class B tolerances require the use of more specialized methodology that may or may not be available or accessible in all areas.

Concrete floor contractors generally take the view of trying to exceed specified tolerances as a best practice. The actual results of using Class B methodology, including suitable concrete materials in adequate ambient conditions, range between FF25 to FF35.

These Class B flatness tolerances have been shown to be suitable for most thin applied finishes. Concrete floor tolerance requirements in excess of FF35 are generally not possible to achieve unless deferred bonded concrete toppings are employed.

ISSUES TO BE RESOLVED BEFORE CERAMIC TILE/ STONE CONTRACTOR BID

DIFFERING FLATNESS SPECIFICATIONS FOR DIVISION 3 AND DIVISION 9

DIVISION 3 FLATNESS REQUIREMENTS

Use ASTM E 1155 (F-number testing)
Measure within 72 hours – Don’t measure near most joints – FF and FL indicates flatness and levelness

DIVISION 9 FLATNESS REQUIREMENTS

Measure the gap under a 10-foor straightedge.

There is no ASTM standard for measuring the gap. – ACI 117 contains straightedge-gap tolerances and some detail on how to measure the gap. – ACI 117 says 100% compliance with a straightedge tolerance of 1/4 in. (6.4 mm) or less is unrealistic, but 100% compliance with a 3/8 in. (10 mm) gap can be achieved. This is for the “flat” floor category. – Straightedge measurement is time consuming and costly.

THE DIVISION 3 AND 9 DIFFERENCES CAUSE MAJOR PROBLEMS FOR FLOORING INSTALLERS

Method for measuring with a 10 ft. (3 m) straightedge.
The straightedge method specifies that the gap observed under a freestanding or leveled 10 ft. (3 m) long straightedge shall not exceed 1/8 in. (3 mm). The problem with this method is that there is no standard method for taking measurements (i.e., number of tests, location, direction) or quantitative procedure for establishing compliance of a test surface.

MEASURING F-NUMBERS ACROSS CONSTRUCTION OR ISOLATION JOINTS

Don't measure F-numbers across construction or isolation joints.

FLATNESS VARIATIONS WITH ELAPSED TIME

Flatness varies with time. The flooring installer doesn't see the floor the concrete contractor produced. The floor the installer sees isn't as flat as it was when the flatness was first measured. Flatness is time sensitive because of curling. Curling changes an initially flat panel into a curved panel with raised edges.

CAUSES OF CURLING

Changes in slab dimensions that lead to curling are most often related to moisture and temperature gradients in the slab. When one surface of the slab changes size relative to the other, the slab will warp at its edges in the direction of relative shortening. This curling is most noticeable at the sides and corners. One primary characteristic of concrete that affects curling is drying shrinkage. Anything that increases drying shrinkage of concrete will tend to increase curling.

The most common occurrence of curling is when the top surface of the slab dries and shrinks with respect to the bottom. This causes an upward curling of the edges of a slab. Curling of a slab soon after placement is most likely related to poor curing and rapid surface drying. In slabs, excessive bleeding due to high water content in the concrete or water sprayed on the surface; or a lack of surface moisture due to poor or inadequate curing can create increased surface drying shrinkage relative to the bottom of the slab. Bleeding is accentuated in slabs placed directly on a vapor retarder (polyethylene sheeting) or when topping mixtures are placed on concrete slabs. Shrinkage differences from top to bottom in these cases are larger than for slabs on an absorptive subgrade. Thin slabs and long joint spacing tend to increase curling. For this reason, thin unbonded toppings need to have a fairly close joint spacing. In industrial floors, close joint spacing may be undesirable because of the increased number of joints and increased joint maintenance problems. However, this must be balanced against the probability of intermediate random cracks and increased curling at the joints. The other factor that can cause curling is temperature differences between the top and bottom of the slab. The top part of the slab exposed to the sun will expand relative to the cooler bottom causing a downward curling of the edges. Alternately, during a cold night when the top surface cools and contracts relative to the bottom surface in contact with a warmer subgrade, the curling due to this temperature differential will add to the upward curling caused by moisture differentials.

Slab Surface is Cooler and Drier than Base - Upward Curling – Typical in Internal Slabs
Slab Surface at a Higher Temperature and Moisture than Base – Downward Curling

CURLING AFFECTS ON FLATNESS/LEVELNESS (ACI 117R-90/ACI 117-06/ACI 117-10)

ACI 117R-90 said curling will not significantly change a floor's FF value. Later data showed this isn't true. Curling also changes the gap under a straightedge. ACI 117-06 and ACI 117-10 do not say curling will not significantly change a floor's FF value. But it doesn't say why that statement from ACI 117R-90 was eliminated.

FACTORS THAT AFFECT SHRINKING

a) Water and cement content
b) Aggregate size and grading
c) Aggregate stiffness
d) Admixtures
e) External restraints
f) Environment

EFFECTS OF HUMIDITY ON SHRINKAGE AND CURLING

If the floor surface is exposed to a high relative humidity, it doesn't shrink much. If the surface doesn't shrink much, the floor doesn't curl much.

GRANULAR WETTING CAUSES

a) Vapor retarder not carried up the side
b) Poor drainage
c) Reverse slope
d) Settlement at the slab edge
e) Roof water not carried far enough away
f) Irrigation water
g) Broken water pipe

Curing (ACI 360 Design of Slabs on Grade) – "Extended curing only delays curling, it does not reduce it"

INCREASED CURING POTENTIAL

a) Don't cure by ponding
b) Avoid most wet curing methods because passage of water through cracks and joints increases moisture content at the bottom of the slab. **This increases curling potential or can be a source of internal moisture that may affect the adhesion of moisture sensitive underlayments, primers or membranes**.

Concrete should be placed directly on an intact vapor retarder (no blotter layer).

Concrete Substrate Issues

Problem	Cause	Cure
Concrete Slab-On Grade Curling	Curling of concrete slab occurs from top to bottom as a result of differential shrinkage (shrinkage of slab where exposed to air; slow or delayed shrinkage at bottom where wet)	Differential curling can be minimized by: • Location of vapor retarder directly beneath slab • Damp curing of slab* • Proper drainage beneath slab • Increased steel reinforcement • Avoid exposure to air movement and protect from hot, dry conditions
Random Shrinkage Cracking (less than1/16 in. [1.6 mm] width)	• Concrete mix design (water, cement) • Aggregate size, grading, type • Admixtures • Restraint of slab (subgrade drag) • Omission, improper placement or insufficient steel reinforcement • Hot, dry, air movement	Shrinkage can be minimized by: • Proper placement/design of control joints • Damp curing of slab* • Increased steel reinforcement • Cool temperatures, high humidity and protect from wind
Excessive Flatness Deviations	• Curling of slab on-grade (especially at control joints) • Dead load (weight) deflection of elevated concrete slab • Improper finishing of concrete surface • Segregation of aggregates	Concrete slab flatness improved by: • Quality control testing of slab per ASTM E1155 after placement** • Check for changes prior to tile installation • Damp curing of slab • Increase steel reinforcement Concrete slab flatness corrected by: • Grinding/scarification • Mortar bed, patching or flowable/self-leveling underlayment • For post-tension slabs, check with contractor before grinding.

* Covering of concrete is the recommended method of curing in preparation of tile installation; curing compounds may be used in lieu of covering, but must be removed by scarification or brushing/washing of concrete as recommended by curing product manufacturer. Water misting or ponding not recommended due to water infiltration through joints and increased potential for slab curling or increase in slab internal moisture that could affect the adhesion of underlayments, primers, or membranes.
** ASTM E1155 allows/does not address excessive concrete flatness deviations that could occur greater than 72 hours after concrete placement, at perimeters, across expansion, control or cold joints or after form removal of elevated concrete.

Photo courtesy LATICRETE International Inc.
Tile contractor – Tile Setters of Raleigh

Concrete Substrate Issues

Problem	Cause	Cure
Standard Flatness Deviations	ANSI A108.01 flatness standards: • Large format tile (greater than or equal to 15 in. [0.38 m]) require no greater than 1/8-in. in 10-ft. (3 mm in 3 m) and 1/16 in. in 2 ft. (2 mm in 610 mm) • Less than 15 in. (0.38 m) no >1/4 in. in 10 ft. (6 mm in 3 m) and 1/16 in. in 1 ft. (2 mm in 305 mm) ACI 117concrete standards: • Allow 1/4 in. in 10 ft. (6 mm in 3 m); local deviation of 3/8 in. (10 mm) allowed; rough equivalent of overall FF equal to 25-35 Disparity between tile and concrete industries' maximum allowable flatness tolerances	• Recommend specification/installation of flowable/self-leveling underlayment or bonded/unbonded mortar bed to achieve required flatness for tile • Increase steel reinforcement to cross-sectional area greater than or equal to 1% Concrete slab flatness corrected by: • Grinding/scarification • Mortar bed, patching or self-leveling underlayment
Surface Imperfections	• Laitance/Scaling/Dusting – weak layer of cement 1/16 in.-3/16 in. (1.6-4.8 mm) depth on concrete surface • Crazing – surface hairline cracking due to rapid evaporation of moisture at surface with excess fine aggregate • Improper hard steel trowel surface inhibits adhesion • Segregation of concrete aggregates • Contamination • Concrete admixtures can cause excessive shrinkage cracking or increase density and inhibit adhesion	• Laitance – adjust mix design; avoid overworking concrete finish and/or freezing of fresh concrete • Crazing – mix design with well graded aggregates; no excess fines; avoid over-finishing; avoid dry shake cement mixtures • Broom trowel finish required for good tile adhesion • Avoid excess water/high slump concrete; avoid finishing if water on surface • Remove dirt residue and clean slab with damp sponge • Test admixtures for compatibility
Structural Cracking (greater than 1/16 in. (1.6 mm) with vertical edge displacement)	• Poor base preparation/compaction • Excessive loading/deflection • Soil settlement/high ground water • Discontinuity of steel reinforcement	• Crack injection with low viscosity structural epoxy or polyurethane • Remove/replace sections of base and concrete per engineer recommendations
Excessive internal moisture	• Lack of vapor retarder beneath concrete • High (seasonal subgrade water levels) • Inadequate cure/drying time • Excessive water/cement ratio • Water leaks, exposure to rain • Lightweight concrete (aggregate retains moisture)	Concrete slab must be suitably dry and tested for internal moisture per ASTM F2170 if any moisture sensitive stone tile, underlayments, primers or membranes are part of the tile assembly.

Photo courtesy of Skyro Floors

Floor Flatness

Floor Flatness (FF) numbers provide a convenient means for specifying floor profiles for flatness and in statistical terms. Since many of the concrete placement specifications are being specified using ASTM E1155 and ACI 117 it is important that tile contractors understand how these methods of measurement evaluate the flatness of a floor profile and the effect it will have on the cost of preparing the surface for tile. This type of specification method can cost additional time and money to prepare floors with acceptable tolerances to receive ceramic tile and provide the owner with functional and aesthetically pleasing installations. Awareness and understanding of these terms and attention to their requirements can substantially impact costs of preparing floors to receive ceramic tile and stone and must be taken into consideration during the bidding process.

Approximate Correlation Equivalence between FF-Numbers and Traditional 10 ft. (3 m) Straightedge			
	Grout Joint Size		
Tile Size	1/4" or larger	3/16"	1/8"
+/- 1/2"	Minimum Subfloor Flatness per ASTM E1155, ACI-117, and ANSI-A108.1B		
8" x 8"	FF25 or 1/4" -10'	FF32 or 3/16" - 10'	FF50 or 1/8" - 10'
12" x 12"	FF25 or 1/4" -10'	FF32 or 3/16" - 10'	FF50 or 1/8" - 10'
16" x 16"	FF25 or 1/4" -10'	FF32 or 3/16" - 10'	FF50 or 1/8" - 10'
18" x 18"	FF32 or 3/16" - 10'	FF50 or 1/8" - 10'	FF60 or 3/32" - 10'
24" x 24"	FF32 or 3/16" - 10'	FF50 or 1/8" - 10'	FF60 or 3/32" - 10'
36" x 36"	FF50 or 1/8" - 10'	FF60 or 3/32" - 10'	FF60 or 3/32" - 10'

An understanding of concrete industry standards is crucial to the tile contractor, as ACI 117 and the ASTM E1155 F-Number System allow, in most cases, much greater levelness and flatness tolerances than current tile industry standards. If a tile contractor is not familiar with these differences when bidding a project, they may unknowingly accept significant concrete substrate preparation work in order to meet the specified tile tolerances, or simply to meet the high level of quality and finished appearance that most professional tile contractors and owners expect. Similarly, design professionals must do a better job in recognizing these potential conflicts, and implement better coordination in project specifications. Accepting and making provisions in the project specifications for the reality of substrate preparation is a more reasonable solution than the traditional (and unreasonable) specification boilerplate excuse that the tile contractor be responsible for "whatever it takes" to prepare and execute the work to industry standards, and that "commencing work constitutes acceptance of the substrate" and all its deficiencies. It is a common mistake for the tile contractor to assume entitlement to a change order increase or backcharge for additional substrate preparation during construction. As a result, the tile contractor may be saddled with a lose-lose situation in having to choose between absorbing substantial additional preparation costs, or rejection of the finished appearance of ceramic tile. It is the duty of the tile contractor to recognize potential substrate problems before submitting a bid.

NOTE: The tile contractor should request all FF reports issued on the project. FF numbers are generally taken within 72 hours of slab placement and may change over time due to conditions, such as curling, settlement, loading and the removal of shoring. The tile contractor is strongly encouraged to have the floors re-evaluated by a third party just prior to installation.

Photo courtesy LATICRETE International Inc.

Concrete Flatness and Level

Problem	Cause	Cure
Acceptable Concrete Substrate Flatness Tolerance	ANSI A108 flatness standards for • Large format tile (greater than or equal to 15 in. [0.38 m]) require no greater than 1/8 in. in 10 ft. (3 mm in 3 m) (ACI Class A) and 1/16 in. in 2 ft. (2 mm in 610 mm); rough correlation FF equal to 50 per ASTM E1155 • Less than 15 in. no greater than 1/4 in. in 10 ft. (6 mm in 3 m) (ACI Class B) and 1/16 in. in 1 ft. (1.6 mm in 305 mm); ACI 117-10 concrete industry standards • Allow 1/4 in. in 10 ft. (6 mm in 3 m) (ACI Class B); local deviation of 3/8 in. (10 mm) allowed; rough equivalent of overall FF equal to 25- 35 • Disparity exists between tile and concrete industries' maximum allowable substrate flatness tolerances ACI 117 concrete industry standards Allow plus or minus 0.3% deviation from level elevation in 10 ft. (3 m) (3/8 in. [10 mm])	• Recommend specification/installation of flowable/self-leveling underlayment or bonded/unbonded mortar bed to achieve required flatness for large format tile. See note below. Note: Thinset or Large and Heavy Tile (LHT mortar) may not be used for truing or leveling.
Excessive Concrete Substrate Flatness Deviations	Concrete slab flatness deviations caused by: • ASTM E1155 flatness testing not required across control or column isolation joints; curling of slab on-grade (especially at control joints) • ASTM E1155 flatness testing conducted within 72 hours before all shrinkage/curling; slab flatness can change over time despite passing test; Examples – dead load (weight) deflection of elevated concrete slab or continued shrinkage/curling of slab	Concrete slab flatness improved by: • Specification and quality control testing of slab per ASTM E1155 after concrete placement • Informal laser level/dipstick testing • Re-check for changes prior to tile installation • FF 25-35 correlates with 1/4 in. in 10 ft. (6 mm in 3 m) (standard tile flatness tolerance) • FF 50-60 correlates with 1/8 in. in 10 ft. (3 mm in 3 m) (large format tile flatness tolerance) Concrete slab flatness corrected by: • Grinding/scarification • Mortar bed, patching or self-leveling underlayment
Excessive Concrete Substrate Flatness Deviations	• Improper placement or finishing of concrete surface; surface defects Tile edge lippage caused by: • Excessive concrete flatness deviations can cause excessive lippage (greater than or equal to 1/8 in. (3 mm) joint)	• FF 50-60 or 1/8 in. in 10 ft. (3 mm in 3 m) (large format tile flatness tolerance) will require mortar bed or flowable/self-leveling underlayment prior to tile installation

Problem	Cause	Cure
	(continued from previous page) Structural cracking (greater than 1/16 in. (1.6 mm) with vertical edge displacement) caused by: • Exceeding concrete slab concentrated load capabilities, settlement or design deficiencies	*(continued from previous page)* Tile lippage/jointing solutions • Increase grout joint width to 3/16-1/4 in. (4.8 - 6 mm) for flatness tolerance of 1/4 in. in 10 ft. (6 mm in 3 m) or agree that lippage can exceed recommended tolerances Structural Cracking – edge displacement corrected by: • Repair and grind – crack injection with low viscosity structural epoxy or polyurethane; grind slab flush/flat • Remove/replace sections of concrete per engineer

Request for Information for Floor Flatness Requirements – Letter

SAMPLE LETTER FOR TILE CONTRACTOR

Refer to Floor Flatness Chart on page 62

American Society of Concrete Contractors (ASCC) Position Statement #6 found on page 66.

Date

Company
Address
City, State Zip

RE: Project
Floor Flatness Requirements

This project includes large format tile (over 15 in. [0.38 m] on one side). Floor flatness tolerances specified for this project in section CSI Master Format 03 30 00 Concrete and Master Format section 09 20 00 Tile do not mandate the tolerance needed for a large format tile. Please provide an allowance for the additional costs that will be incurred to meet the floor flatness needed for large format tile or specify the applicable *TCNA Handbook for Ceramic, Glass, and Stone Tile Installation* method to be used.

Please reference attached copy of American Society of Concrete Contractors (ASCC) Position Statement #6 regarding large format tile.

Name and Title
Company

Division 3 versus Division 9 Floor Flatness Tolerances

American Society of Concrete Contractors (ASCC) Position Statement #6

Division 3 specifications for concrete floor flatness typically include Floor Flatness (F_F) requirements. The specifications also require that floor tolerance measurements be taken in accordance with ASTM E-1155, "Standard Test Method for Determining F_F Floor Flatness and F_L Floor Levelness Numbers." Thus, the F-number measurements for meeting Division 3 requirements incorporate the following:

- Point elevations measured at regular 12 in. (300 mm) intervals along each line;
- Measurement lines distributed uniformly across the test section;
- Minimum number of readings required for statistical approach;
- Measurement lines not within 2 ft. (0.6 m) of any slab boundary, construction joint, isolation joint, block-out, penetration, or other similar discontinuity; and
- Flatness measured within 72 hrs. of concrete placement.

Division 9 specifications for concrete floors to receive a floor covering typically provide floor flatness requirements in terms of an allowable gap under an unleveled straightedge. There is no ASTM procedure for this measurement. Straightedge measurements for Division 9 incorporate the following:

- Continuous measurement at any gap under the straightedge;
- Indefinite number of straightedge locations on the floor;
- No minimum or maximum number of readings;
- Measurements typically made with the straightedge crossing construction joints or column block-outs, and near penetrations; and
- Measurements made just prior to floor covering installation, which can be from 4 to 18 months after concrete placement.

Division 3 and 9 floor flatness tolerances are obviously not compatible. There is only a rough correlation between F_F numbers and the gap under a straightedge. F-number measurements don't include flatness variations indicated by straightedges placed across construction joints and column block-outs. And floor flatness changes with time (due to curling) make it impossible to predict the flatness when floor coverings are installed, based on F_F measurements made soon after concrete placement.

Despite this incompatibility of tolerance-measuring methods, some specifiers believe concrete contractors should be responsible for taking corrective action when Division 9 floor flatness requirements aren't met. To further complicate this issue, concrete contractors seldom receive Division 9 specification requirements when bidding. The floor covering often isn't chosen – and Division 9 isn't written – until after the concrete contract is signed, and sometimes until after the concrete is placed.

Concrete contractors are responsible for meeting the requirements of Division 3 specifications for floor flatness. To reduce the effect of curling on floor flatness, ASCC contractors suggest that the engineer consider using 0.5% reinforcing steel (both ways) and placed within the top half of the slab. Whether reinforcing is used or not, ASCC, NWFA, FCICA, IMI, BAC, TCAA and NTCA suggest that the owner provide a bid allowance, established by the A/E and based on the floor covering requirements, for any necessary grinding and patching to close the gap between Division 3 tolerances and Division 9 tolerances. Providing an allowance enables the owner to compare floor covering bids on an equal basis. Any unused allowance money is returned to the owner.

If you have any questions, contact your ASCC concrete contractor, the ASCC Technical Hotline at (800) 331-0668, the NWFA at (800) 422-4556, FCICA at 248-661-5015, IMI at (410) 280-1305, BAC at (202) 783-3788, TCAA at (816) 868-9300 or the NTCA at 601-939-2071.

Update: Section 4.8.6 of ACI 117-10, "Specifications for Tolerances for Concrete Construction and Materials and Commentary," contains minimum sampling requirements for testing surface flatness evaluated by using a straightedge. ASTM E1155-96 (2008) supersedes ASTM E1155-96 but contains the same requirements.

(08-11 updates replace 04-09 revisions)

As published in *Concrete International*, a publication of the American Concrete Institute	Revised 04/09

Photo courtesy of Cox Tile

NTCA White Paper
Wall-Flattening Products

Substrate tolerances for installing tile with one edge less than 15 in. (0.38 m) on vertical surfaces are 1/4 in. in 10 ft. (6 mm in 3 m), 1/16 in. in 1 ft. (2 mm in 305 mm) while substrate tolerances for installing tile with one edge 15 in (0.38 m) or longer on vertical surfaces are 1/8 in. in 10 ft. (3 mm in 3 m), 1/6 in. in 2 ft. (2 mm in 610 mm). To flatten walls to meet these tolerances, products specially manufactured for this purpose should be used. In many cases the use of thin-set mortars may exceed the intended purpose and product limitations designed by the manufacturer. Many manufacturers make products specifically designed to flatten wall surfaces to meet industry tolerances. All products should be used in accordance with the manufacturer's installation instructions and directions. As with all installations, it is best to use one manufacturer's products on any single project in order to maintain a single source product warranty that covers the entire system. If single product sourcing is not available, check with the manufacturers used in order to confirm compatibility among products.

Please contact your manufacturer for assistance with product selection and installation guidelines.

Photo courtesy of Cox Tile

Photo courtesy of Columbia River Tile & Stone

Underlayments

Introduction

Factory-prepared, powdered underlayments can be trowelable or pourable/flowable, and usually fall into one of two categories:

1. Gypsum based
2. Cement based latex underlayments

1. Gypsum based underlayments. (trowelable)

Gypsum based patching compounds are polymer-fortified materials, composed of gypsum and other chemicals and are typically fast setting but not fast drying. They can be used for floors and or walls. They may be mixed with water or a latex admixture, (for greater strength), but are to be used only in dry areas since gypsum-based materials are more sensitive to moisture than cement-based materials. When exposed to water, these products become soft and may swell therefore the use of them in wet areas is highly cautioned. These materials are normally used in the resilient flooring industry for patching small holes, cracks or for correction of thickness variations of adjacent flooring materials, up to 1/2 in. (12mm). However, larger areas may be leveled covered with products that can go from 1/8 in. (3mm) up to 2 in. (50mm) in most cases, with a pourable material. Prior to installing ceramic or porcelain tile over a gypsum-based underlayment, it is recommended that the underlayment be primed. Priming the surface before applying the mortar will act as a “sealer” between the mortar and underlayment, preventing premature drying of the mortar or adverse chemical reactions between a Gypsum product and a Portland cement product. Waterproof membranes can also be used to protect the underlayment from top-down moisture and give you a better bonding surface for the mortar.

2. Cement based underlayments, (trowelable)

Cement based underlayments are formulated from a blend of Portland and hydraulic cements and are very fast setting and drying. They can be used for floors or walls. While typically un-sanded, some cement based underlayments have a very fine sand aggregate in them for thicker applications. Cement based underlayments are usually mixed with water but can also be mixed with a latex or an acrylic additive, for strength, flexibility, and better bonding. Cement-based underlayments can be installed over a variety of substrates. They can be installed directly over concrete or wood without a primer and can be installed over a non-porous substrate with the use of a primer. Texture is not needed for bonding purposes, but the surface must be porous. If the surface is not porous, a primer must be used to bond to the substrate.

3. Flowable hydraulic cement underlayments, (aka pourable/flowable self-leveling compounds) are pourable/flowable and are composed of Portland cement, fine aggregates and a variety of select polymers, that increase flowability, setting and strength. Substrate priming is required when using a flowable hydraulic cement underlayment for purposes of bonding and for greater working time. Wood substrates are usually primed with an acrylic or latex primer. Concrete substrates are usually primed with an acrylic, latex or epoxy primer. Non-porous substrates are usually primed with an epoxy or latex primer. Always check with the manufacturer for priming recommendations. Most flowable hydraulic cement underlayments are mixed with water, but some may be mixed with a latex admixture for better bond strength and flexibility. Flowable hydraulic cement underlayments can be applied from 1/8 in. (3mm) up to 2 in. (50mm) neat or can be extended with the addition of aggregate. Check with manufacturer. Although not as vulnerable to moisture as gypsum-based underlayments, it is recommended a waterproof membrane be applied over the cement-based underlayment prior to the installation of tile in wet areas.

Photo courtesy of Custom Building Products

Poured-Gypsum Underlayments

Poured-gypsum underlayments can provide a satisfactory surface to receive ceramic tile installation systems that are poured at a minimum of 1/2 in. (12 mm) over a structurally sound concrete or precast subfloor, a structurally sound wood subfloor at a minimum of 3/4 in. (19 mm), or a sound mat shall exceed 1 in. (25 mm) in depth and must support design loads with a maximum L/360 deflection. These floors are available in compressive strengths of 1,000 to over 8,000 PSI. Poured-gypsum concrete underlayment shall have a minimum compressive strength of 2,000 PSI for use over wooden substrates, 3,000 PSI for use over a concrete substrates and a minimum density of 105lbs. per cubic foot when tested in accordance with ASTM C472. Poured-gypsum underlayments are suitable for interior substrates only, above grade, and in areas not subjected to water exposure or immersion.

There are currently four approved methods the *TCNA Handbook* uses for poured-gypsum underlayments in tile installations.

F200 – Poured-Gypsum over Concrete
F180 – Poured-Gypsum Underlayment over Plywood
RH111 – Poured-Gypsum over Concrete with Hydronic Heat
RH122 – Poured-Gypsum over Wood with Hydronic Heat

Drying of the gypsum underlayment

Poured-gypsum floors are made with a job site mixture of powder and water and require time to dry before they can be primed/sealed and tiled. Verification that the gypsum underlayment is dry can be determined in accordance with ASTM D4263: Plastic Sheet Method. This test process shall be performed by the gypsum installer, prior to the application of any primers/sealers. <u>Do not</u> proceed with the tile installation until the poured-gypsum is deemed dry <u>and</u> has been primed/sealed.

As a general guideline, the following drying times should be observed prior to testing the surface for dryness.

Thickness of poured-gypsum	Dry time before testing
1/4 in. (6mm)	48 hours
1/2 in. (12mm)	72 hours
3/4 in. (19mm)	5 days
1 in. (25mm)	7 days
2 in. (51mm)	2 weeks

Preparation of the poured-gypsum surface

In general, ceramic tile is not bonded directly to gypsum underlayments. While each manufacturer of these materials has their own specific requirements, the use of a primer/sealer or a primer and membrane is required. Any exceptions to this recommendation are proprietary in nature and suitability rests solely with the gypsum manufacturer.

PRIMER/SEALER

Some gypsum manufacturers recommend the use of a primer/sealer over the surface of the dry gypsum before installing any membrane or setting material directly. Also referred to by some as a “sealer” or “overspray,” the use of these primers is intended to prevent the gypsum from absorbing water from the setting material, which can result in poor adhesion. Please note that while you may not have installed the poured-gypsum, you must verify that the primer/sealer was applied in accordance with the manufacturer’s recommendations, after the gypsum floor was deemed dry.

MEMBRANES

The Tile Council of North America and some gypsum manufacturers recommend the use of membranes in addition to the primer prior to installing the tile over their poured underlayments. For the purposes of these applications, membrane is as defined by ANSI A118.12 for crack-isolation or ANSI A118.10. Check with the manufacturer for their individual requirements.

NOTE: The tile contractor shall obtain written documentation verifying that the poured-gypsum floors have met or exceeded the minimum compressive strength of 2,000 psi and minimum density requirements of 115 lbs. per cu. ft. per ASTM C472, have been tested per ASTM D4263 and deemed to be dry, and have been primed/sealed in accordance with the manufacturer’s recommendation. This information shall be provided to the tile contractor by the general contractor, owner, builder or certified poured-gypsum installer.

NOTE: The requirements of this document exclude patching compounds.

Tile Over Poured-Gypsum Underlayments and Leveling Materials

Caution

Gypsum based underlayments are predominantly composed of various grades of gypsum to which chemicals are added for controlling setting time and, in some cases, to provide flowability. They may be sanded or unsanded. They may be mixed with water or a latex admixture. Gypsum based materials are highly sensitive to moisture. Therefore, they are recommended by gypsum manufacturers for use in dry areas only. These materials are normally used by the resilient flooring mechanic for patching small cracks and holes or for correction of thickness variations of adjacent flooring materials. Larger areas may be leveled with gypsum-based products, which requires a minimum thickness of 3/4 in. (19 mm) over wood and 1/2 in. (12 mm) over concrete substrates. Poured-gypsum underlayments are not recommended for direct use under tile because of their sensitivity to water. In addition some types have poor strengths that can contribute to cohesive failure within the gypsum product itself. Formulation changes of some gypsum-based materials, including Portland cement, have prompted claims that they are suitable to receive tile. Another recommendation is the application of specific waterproofing membranes over, and bonded to, the gypsum materials to which the tile is applied. Extreme caution should be exercised by general contractors and tile contractors when substrates of gypsum materials are encountered. The gypsum material manufacturer should be contacted for specific tile installation procedures to use over their products, supported by satisfactory performance test data.

Tile Over Poured-Gypsum Underlayments and Leveling Materials – Letter

NOTE TO THE TILE CONTRACTOR

The tile contractor should require in writing a letter from the product manufacturer relieving him of responsibility for the performance of any tile installation over poured-gypsum products.

Date

Name
Address
City, State Zip

Re: Project
Tile Over Poured-Gypsum Underlayments and Leveling Materials

The substrate to receive tile on the (project name) is or is specified to be a gypsum-based material. Gypsum-based materials are not recognized by the American National Standard Specifications for the Installation of Ceramic Tile as a suitable substrate.

These specifications state in Section AN-2.4.2 that substrates subject to damage by exposure to water require a cleavage membrane or a traditional waterproof membrane to separate that surface from the mortar setting bed and tile. The mortar setting bed referred to in this section is a minimum 1-1/4 in. (32 mm) Portland cement mortar bed.

If I am required to set tile by a thin-set method over the gypsum-based material or over a bonded waterproof membrane, I shall not proceed with the installation until I have received a letter stating that I am not responsible for the performance of this installation.

Name and Title
Company

Flowable Hydraulic Cement Underlayment (FHU)/ Self-Leveling Underlayment (SLU)

Poured cementitious underlayments can provide a satisfactory surface to receive ceramic tile installation systems that must support design loads with a maximum L/360 deflection. These floors are available in compressive strengths of 3,500 to over 7,000 PSI and are installed in as little as 1/16 in. (2 mm) to as deep as 6 in. (152 mm). Poured cement-based underlayments generally have a density of 120 lbs. per cubic foot. Poured cement-based underlayments are suitable for interior substrates.

There are currently nine approved methods in the *TCNA Handbook* for poured cement-based underlayments in tile installations.

- F205 and F205(A) - Flowable Hydraulic Cement Underlayment (FHU)/Self-Leveling Underlayment (SLU) over Concrete
- F185 - Flowable Hydraulic Cement Underlayment (FHU)/Self-Leveling Underlayment (SLU) over Wood
- RH112 & RH112 (A) - Flowable Hydraulic Cement Underlayment (FHU)/Self-Leveling Underlayment (SLU) over Concrete with Hydronic Tubing RH116 & RH116 (A) - Flowable Hydraulic Cement Underlayment (FHU)/Self-Leveling Underlayment (SLU) Underlayment over Concrete with Electric Radiant Heat RH123 - Flowable Hydraulic Cement Underlayment (FHU)/ Self-Leveling Underlayment (SLU) over Wood with Hydronic Tubing
- RH140 - Cementitious Self-Leveling Underlayment over Wood with Electric Radiant Heat

Drying of the cement-based underlayment
Poured cement-based underlayments are made at the job-site and mixed with pre-blended powder and water. This material generally requires very little dry time, usually 2 - 24 hours, before the final floor can be installed. Check with the manufacturer for required curing times before installing the final flooring system.

Preparation of the poured cement-based underlayment surface
When installed correctly, these underlayments require very little, if any prep at all before installing the final floor system.

MEMBRANES
The *TCNA Handbook* has recommendations for the use of optional membranes prior to installing the tile over poured underlayments. For the purposes of these applications, membrane is as defined by ANSI A118.12 for crack-isolation or ANSI A118.10 for waterproof. Check with the manufacturer for their individual requirements.

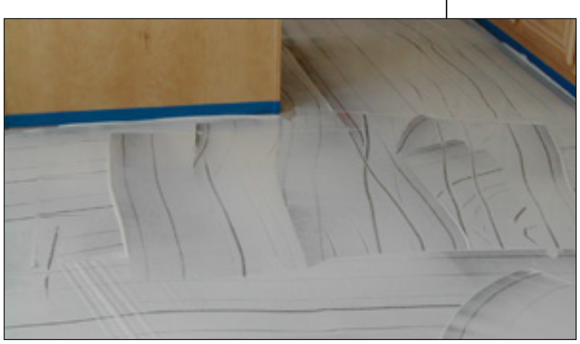
NOTE: The tile contractor shall obtain written documentation verifying that the poured cementitious floors have met or exceeded the minimum compressive strength requirements of the project. This information shall be provided to the tile contractor by the general contractor, owner, and builder and/or certified poured-gypsum installer.

NOTE: The requirements of this document exclude patching compounds.

Photo courtesy of Custom Building Products.

Loss of Underlayment Bond To Substrate

Problem	Cause	Cure
Improper substrate surface preparation. Application of material over dust, dirt, curing compounds, old adhesives, paint, spalled or soft concrete, etc.	Most applications lose bond below the actual underlayment material pulling the dirt, curing compound, old adhesives or soft concrete up with it. Some residue of the contamination may still be left on the substrate.	Follow underlayment manufacturer surface preparation recommendations. Remove all surface contaminants to expose a clean concrete substrate using a grinder or by shot blasting to achieve a minimum ICRI profile of 3. Remove all loose contaminants using a vacuum. Do not use a scrape away type machine as this may leave a thin residue that is difficult to bond to. For plywood substrates, use lath or manufacturer approved primer and methods for underlayment being used.
Substrate deflection.	Loss of bond will usually occur at the substrate and underlayment interface. On thicker applications, rupture may occur within the matrix of the underlayment.	Maximum allowable live load and concentrated load deflection is L/360 for tile and L/720 for natural stone where "L" is the clear span length. Follow deflection requirements as specified in ANSI A108.01-2.3 and *TCNA Handbook* substrate requirements.
Improper substrate priming or lack of primer.	Incomplete curing or hydration of the underlayment due to excessive or rapid absorption of water into the substrate. Use of a non-approved latex or primer that acts as a bond breaker.	Use only underlayment manufacturer recommended primer. Many primers serve three functions: acting as a bonding agent, as a sealer to control water absorption into the substrates and minimize outgassing.
Diluting latex additive with water.	Adding water to latex additives reduces the latex solids content in the final mix, decreases the bond, inhibits hydration or hardening. Loss of bond may occur at underlayment and primer interface or within the matrix of the underlayment. Latex underlayment may be soft and crumbly.	Never dilute latex additives unless specifically stated in the directions.
New or Green Concrete (under 28 days old).	Concrete substrate continues to shrink as it cures during the first 28 days.	Allow concrete to cure a minimum of 28 days. Consult underlayment manufacturer for installation over concrete cured less than 28 days.



Using latexes other than those designed for the underlayment can act as a bond breaker.

Cracking

Problem	Cause	Cure
Mixing product with too much water or latex additive.	Excess water or latex additive creates excessive voids in the cured underlayment matrix that leads to high shrinkage, cracking, soft chalky surface, lower compressive, tensile, and flexural strength and possibly debonding.	Always follow manufacturer recommended mix proportions. Always carefully measure water for each mix during installation per manufacturer's instructions.
Bridging expansion, control joints, or slab cracks.	Bridging joints and cracks that expand and contract will cause the underlayment to crack.	Honor or properly repair all moving cracks, expansions and control joints. Provide perimeter joints to accommodate moisture or thermal movement.
Application greater than specified maximum thickness.	Underlayments contain aggregates to control shrinkage when applied within proper thickness. If the thickness limitations are exceeded, the aggregate does not control the additional shrinkage experienced by the larger mass of material.	Check manufacturer instructions to determine if additional aggregate may be added for thicker applications or if multiple pours are allowed. If not, a different type of underlayment may be required.
Over-working surface.	Over-working will bring the water and/or latex to the surface of the underlayment creating excess voids in the top layers. When the excess water evaporates, the cement particles try to occupy the voids left behind causing excessive shrinkage and cracking.	Do not over work the underlayment any more than is essential for getting a smooth surface.
Exposure to excessive wind or direct sunlight during initial curing stage.	Exposure to high air movement, heat or sunlight will cause rapid water loss on the surface causing incomplete hydration of the underlayment in this area. As the lower levels of the underlayment cure and experience normal shrinkage, the top layer will crack.	Prevent direct sunlight or wind exposure to freshly applied underlayments. Do not forget flowable/self-leveling underlayments.
Not using a primer.	Rapid absorption or moisture in the underlayment.	Follow manufacturer's recommendations for priming.

Cracks and Their Treatment – Letter

LETTER FOR THE TILE CONTRACTOR

Date

Name
Address
City, State Zip

RE: Cracks and their treatment

- The architect, builder or design professional must specify movement joints and show location and details on drawings.
- It is not the intent of the *TCNA Handbook for Ceramic, Glass, and Stone Tile Installation* (*TCNA Handbook*) or ANSI Standards and Specifications for the Installation of Ceramic Tile to make movement joint recommendations for a specific project.
- It is particularly important when dealing with a cracked substrate that expansion joints are properly located and filled with a suitable sealant, or prefabricated expansion joint. All joints; expansion, control, construction, cold, saw-cut, isolation, contraction, and seismic, in the substrate should continue through the tile installation, including such joints at vertical surfaces. If this is not desirable or possible, consult with the manufacturers involved, select only those products they recommend, and carefully follow their installation instructions. Require their written warranties for installations that are not specifically and fully covered by existing industry methods and specifications.
- If a crack-isolation membrane is specified over saw-cut joints that are intended for relocation of movement joints complying with *TCNA Handbook* Method EJ171, the tile contractor shall not be responsible for cracking in grout joints or tile over such joints when installed correctly. Relocation of movement joints is especially not recommended where tile patterns are installed diagonally across saw-cut joints because of their reduced performance. Use of saw-cut joints as relocation of movement joints is especially not recommended. Where tile patterns are installed diagonally across saw-cut joints the performance of existing movement joints is reduced.
- Careful examination and evaluation of your project to determine the type, size and extent of cracks to be treated are essential for selection of a trowel applied, liquid and/or sheet membrane to minimize crack propagation from the substrate.
- Ascertain that the manufacturer's warranty adequately and specifically states what it covers for your project. Some warranties cover replacement of their product only and not the entire failed installation of tile, stone, setting materials and labor.

Name and Title
Company

Photo courtesy of Chip O'Rear, Custom Building Products.

Soft or Powdery

Problem	Cause	Cure
Non-uniform cured matrix. Sand at the bottom and thin cement cream at the surface.	Excessive water or latex additive causes the underlayment to segregate with the sand sinking to the bottom and the fine particles, cement binder to float to the surface.	Always gauge the liquid and powder according to manufacturer directions.
Improper mixing.	Using the wrong mixing speeds can develop air in the mix, once cured the air bubbles dissipate leaving a void in the mix. These air pockets significantly decrease the strength of underlayments.	Always mix following the manufacturer's instructions.
Diluting latex additives with water.	Diluting latex additives with water, when not called for in the directions, can cause rapid evaporation of water from the applied material. This greatly reduces cement hydration or curing resulting in a very weak underlayment.	Always use proper proportions according to manufacturer directions.
Using gypsum based materials in areas subject to moisture.	Gypsum based materials are very sensitive to water. Even latex modified gypsum based materials, after curing, will turn powdery or soft and mushy when exposed to enough moisture, is powdery or soft and mushy.	Use a cementitious underlayment or consult gypsum based underlayment manufacturer for directions.
Using cement based underlayment over gypsum underlayment.	Gypsum based products are sensitive to water. When cement based products containing latex additive or water are applied over gypsum, the water softens the gypsum. Then, when the cement product goes through its normal shrinkage while curing, it pulls the weakened gypsum product apart.	Use only cement based products manufacturer recommended for use over gypsum products.
Mixing with foreign products or substituting one product for another.	Many products may appear to be the same, especially latex additives and primers, however, various raw materials may be contained in the same basic type of latex, which changes its performance characteristics.	Consult underlayment manufacturer for approval before making any substitutions

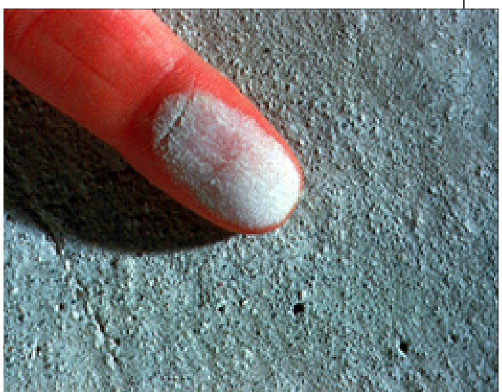
Problem	Cause	Cure
(continued from previous page) Moisture penetration followed by freeze/thaw cycles.	*(continued from previous page)* Underlayment not designed for exposure to water or freeze-thaw environment.	*(continued from previous page)* Protect the underlayment installation from freeze/thaw conditions. Consult manufacturer for recommended environmental use conditions and product limitations.
Underlayment used as a wear surface. 	Underlayment is soft, powdery or wearing off the surface.	Always use a product designed for the intended function.

Photo courtesy of Daltile.

Photo courtesy of Custom Building Products

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MEMBRANES

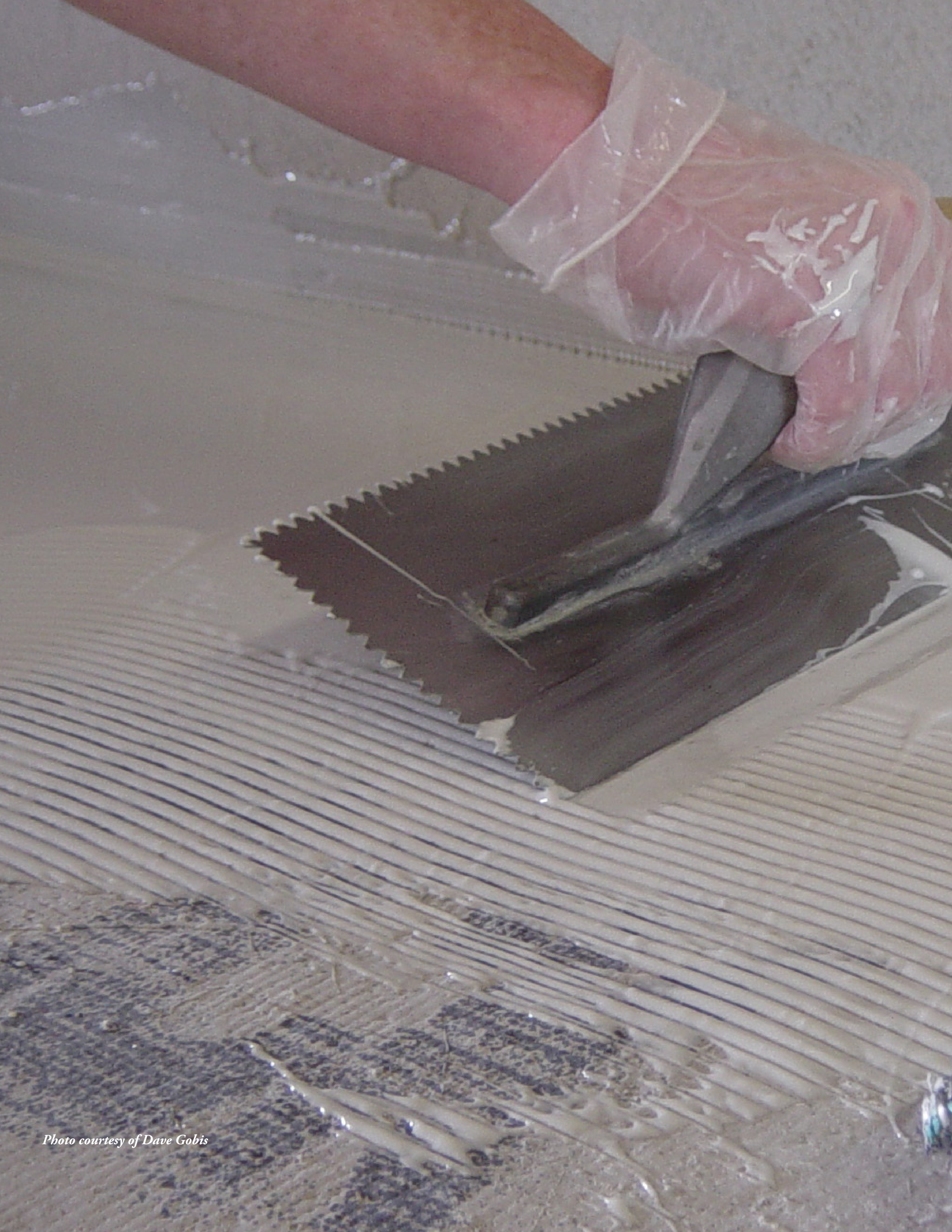

Photo courtesy of Dave Gobis

Chapter 3
Membranes

Types of Membranes

PURPOSE: This document is intended to identify and define the different membranes that can be associated or incorporated into a ceramic tile installation.

CLEAVAGE MEMBRANES

A cleavage membrane is a thin layer of material within a tile assembly that is loose laid (floating) or mechanically attached but not bonded. Cleavage membranes are incorporated below the mortar setting bed in a thick-bed tile installation when the backing or substrate surface can be damaged by water, is not continuous, is cracked, or is dimensionally unstable. The cleavage membrane separates the backing surface from the mortar setting bed and tile, allowing the mortar setting bed to be unbonded and free floating, and thereby not subject to the instability of the backing surface, preventing reflective cracking. When a cleavage membrane is incorporated, the setting bed is required to be reinforced with lath or wire, see ANSI A108.1A.

Cleavage membranes are always materials that are moisture resistant. Cleavage membranes do not necessarily form an impermeable membrane that will hold water, but are intended to provide other materials some protection from moisture and vapor. Typical cleavage membranes include roofing felt, reinforced asphalt paper, asphalt laminated paper, polyethylene sheeting, chlorinated polyethylene (CPE) sheeting, polyvinyl chloride (PVC) membrane, or high-solids, cold-liquid-applied membrane. ANSI A108.02-3.8 provides the specific requirements for these various materials. Some of these same materials can be used as a vapor retarder membrane. See Vapor Retarder Membranes.

CRACK-ISOLATION MEMBRANES

Crack-isolation membranes (sometimes marketed as anti-fracture membranes) for thin-set ceramic tile and dimension stone installations act to isolate the tile or stone from minor, in-plane substrate cracking meet ANSI A118.12. These membranes may be bonded to a variety of substrates approved by the manufacturer. The contractor should check with the manufacturer to determine the limitations of crack movement the specific material will tolerate. There are two basic types of crack-isolation membranes: sheet applied and liquid applied.

Sheet Applied Membranes are usually provided in rolls consisting of a flexible material with some amount of elasticity that allows the material to elongate while remaining adhered to the substrate. Some of these membranes have integral reinforcing fabrics to enhance the tensile strength of the material as well as provide a better bonding surface for thin-set mortars.

Liquid Applied Membranes may be single or multi component membranes applied in a liquid form using a trowel, roller, or sprayer. These membranes cure into a continuous crack-isolation membrane, which allows direct bonding of ceramic tile, usually with latex Portland cement mortar. Some liquid applied membranes require embedding a fabric into the membrane to increase tensile strength.

The TCNA Handbook addresses Crack-Isolation Membranes in Methods F125-Partial and F125-Full. F125-Partial is for specifying application of a Crack-Isolation Membrane over existing in-plane cracks when the material is applied only in the vicinity of the existing cracks. F125-Full is for specifying the Crack-Isolation Membrane to be applied throughout the installation to protect against existing cracks as well as future in-plane cracking that may develop.

WATERPROOF MEMBRANES

Waterproof membranes for thin-set ceramic tile and dimension stone installations function as barriers to positive liquid water migration meet ANSI A118.10. Among these are sheet applied membranes and liquid applied membranes, which can be bonded to a variety of manufacturer approved substrates.

Sheet Applied Membranes are usually provided in rolls consisting of a waterproof, flexible material that is to be adhered to the substrate. Some of these sheet applied membranes have integral reinforcing fabrics to enhance the tensile strength of the material as well as provide a better bonding surface for thin-set mortars.

Liquid Applied Membranes may be single or multi component membranes applied in a liquid form using a trowel, roller, or sprayer. These membranes cure into a continuous waterproof membrane, which allows direct bonding of ceramic tile, usually with latex Portland cement mortar. Some liquid applied membranes require embedding a fabric into the membrane to increase tensile strength.

LOW PERM WATERPROOF MEMBRANES

Low perm waterproof membranes are membranes meeting ANSI A118.10 and have water vapor permeance values of 0.5 perm or less, determined per ASTM E96, Procedure E (desiccant method at 90°F) and 90% relative humidity. Manufacturers should be consulted when water vapor is of special concern, for example in steam rooms, because not all waterproof membranes are effective at retarding vapor transmission. Not all waterproof membranes meeting ANSI A118.10 are low perm waterproof membranes.

Source: Excerpted from "Membrane Selection Guide," in *TCNA Handbook for Ceramic, Glass, and Stone Tile Installation*, p. 22. Anderson, SC: Tile Council of North America, 2012.


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Types of Membranes

MOISTURE BARRIERS

Moisture barriers are designed to substantially reduce or eliminate moisture migration from the substrate (normally concrete) into the flooring adhesive, setting material or the flooring material itself. The term "Moisture Barrier" is a bit misleading and most of these membranes do not provide an absolute barrier for moisture contained in the normal vapor flow through concrete substrates. They function more specifically as a moisture vapor "retarder" because they do allow moisture vapor to penetrate the membrane but at a substantially reduced rate than an untreated concrete substrate would. These membranes are normally associated with the resilient flooring industry (sheet vinyl, VCT, carpet and wood), which sets limitations on the amount of moisture flow allowable prior to the installation of resilient products. These limitations are set because excessive moisture may cause warping of wood products, mildew growth under sheet vinyl or VCT or even deterioration of adhesives normally associated with these products. When tested for moisture migration with a standardized calcium chloride test, many manufacturers of resilient materials require the moisture flow to be less than 5 pounds per 1,000 square feet in 24 hours and some require less than 3 pounds. Moisture barriers can reduce excessive moisture flows to within the allowable limits.

Most moisture barriers are liquid applied. Some are applied as a topical membrane forming a continuous membrane on the surface of the substrate and some are applied as a penetrating material that fills the pores and capillaries of the concrete, thereby reducing the avenues available to moisture flow. Other materials used as moisture barriers penetrate and use some of the constituents of concrete to induce crystalline growth, thereby increasing the density of the concrete itself and reducing moisture flow.

Moisture flow under 12 pounds per 1,000 square feet is normally not considered detrimental to a ceramic tile installation installed with standard dry-set mortar. Tile set with latex Portland cement mortars need not be concerned unless the moisture flow is above 10 pounds per 1,000 square feet. This is because ceramic tile installations set with Portland cement based products can "breathe" allowing the moisture to escape without doing damage to the installation. There should be concern when moisture flows in excess of 12 pounds per 1,000 square feet are encountered. Many times this is an indication of hydrostatic pressure, green (uncured) concrete or moisture being introduced to the concrete from an outside source. If the tile is being set with adhesive or epoxy products, check with manufacturer for their limitations on moisture flow.

UNCOUPLING MEMBRANES

Uncoupling membranes for thin-set ceramic tile and dimension stone installations are geometrically configured to provide air space and lateral flexibility between the tile and substrate to allow independent movement between the two and prevent the transfer of stresses to the tiled surface that could otherwise cause damage. These sheet membranes are applied throughout the area being tiled over various manufacturer approved substrates. Uncoupling membranes accommodate differential movement between the tile layer and substrate, including in plane crack movement and expansion and contraction due to changes in moisture content, temperature, and loading, without loss of bond to the substrate or the tile. These membranes do not currently have a standard, check with manufacturer for limitations, testing, and installation of products.

VAPOR RETARDER MEMBRANES

No material can completely eliminate water vapor transmission. However, the transmission of vapor can be effectively controlled through the use of a vapor retarder membrane. These membranes are used in wet areas, placed behind mortar bed walls and some types of backer boards to retard moisture and vapor transmission into the wall cavity.

Source: Excerpted from "Membrane Selection Guide," in *TCNA Handbook for Ceramic, Glass, and Stone Tile Installation*, p. 21. Anderson, SC: Tile Council of North America, 2016.

Photo courtesy of Allison Eden Studios

Crack-Isolation Systems

INTRODUCTION
Crack-isolation systems for ceramic tile and stone installations are intended to accommodate anticipated movement and related stress that a substrate exerts on the installation without adversely affecting the performance or appearance of the finished installation.

These materials are typically applied to existing substrates that exhibit shrinkage cracks, settling cracks, cracks associated with structural deficiencies or cracks related to the thermal movement of the substrate material. Yet, their application to new substrates that do not exhibit any of these deficiencies is steadily increasing. In these instances, crack-isolation systems are intended to negate or reduce the effects of cracks in the tile that might develop at a later date.

Crack-isolation systems include, but are not limited to, composite sheet materials and cold, liquid-applied materials.

In some cases, crack-isolation systems can be applied in narrow bands over existing cracks in the substrate. In other cases, crack-isolation systems are intended for application over the entire substrate surface.

Refer to *TCNA Handbook* methods F125 Partial and F125 Full for more information on the respective treatment methods.

For proper performance, individual manufacturers must be consulted for specific installation instructions, application techniques and any system limitations. Follow the individual manufacturer's written instructions precisely.

Contractors are not encouraged to design their own crack-isolation systems since the inherent liability of a failure is so great.

PRELIMINARY
Inspect and identify the nature and extent of the problem.

Qualify the situation to determine the expected results, i.e. the acceptable level of cracked tile or grout joints after the procedure has been accomplished.

Contact the manufacturers of crack-isolation systems to determine if their materials can accommodate the existing conditions. Request that they visit and inspect the installation.

All concerned parties should be aware that the best systems may not overcome all deficiencies of the substrate. But, a crack-isolation system is preferable to bonding the tile directly to the cracked substrate. The deficiencies noted in the inspection may become worse after installing the tile without a crack-isolation system. Remember, the crack-isolation system is intended to negate the noted deficiencies of the substrate.

LIMITATIONS
Crack-isolation membranes shall not be used to relocate any type of movement joints. Movement joints in tile shall coincide with movement joints in the substrate, i.e. construction joints (cold joints), contraction joints (saw-cut joints), expansion joints and isolation joints.

Even with a crack-isolation system, *TCNA Handbook* EJ171 still requires expansion, control, and isolation joints.

Crack-isolation systems are designed to work with cracks between level planes of substrates. When cracks in the substrate are not on the same plane, crack-isolation systems are of questionable value. In this case, expansion joints are required.

Isolation systems used on cracks brought to plane may offer some advantages, however, their value remains questionable.

Cracks over 1/8 in. (3 mm) in width are considered major cracks and may or may not be accommodated by crack-isolation systems. Attempt to determine the cause of the cracks and consult with available manufacturers to determine suitable application procedures.

Some crack-isolation systems may not be capable of withstanding the rigors of certain installations. Consult with owners and manufacturers to determine the intended service requirements of the installation. The service ratings delineated by the Robinson Floor Tester, ASTM C627, may be useful for this purpose.

CONCLUSION
Effective use of crack-isolation systems involves pre-installation conference and consultation with all concerned parties. These discussions should include substrate evaluation, system application techniques and the limitations of the chosen crack-isolation system. Finally, a qualification regarding the acceptability of any cracked tile or grout joints should be determined and agreed upon by all concerned parties before any work begins.

Photo Courtesy of Jamie Gold Kitchen, Bath and Wellness Design, LLC

Waterproof Membrane Document

NOTE: Not all waterproof membranes meet the requirements of ANSI A118.10. Waterproofing applied by other trades may not comply with ANSI A118.10 and may be difficult or impossible to bond with the setting materials used in the ceramic tile industry. When the waterproofing has been applied by others, determine what material was used and consult the setting material manufacturer to determine compatibility with specific setting materials.

TYPICAL USAGE OF ANSI A118.10 WATERPROOF MEMBRANES OCCURS IN THE FOLLOWING AREAS

A. Above grade restrooms – residential and commercial
B. Parking garages over working or living areas
C. Balconies
D. Roof decks
E. Steam showers
F. Gang showers
G. Normal showers – residential and commercial
H. Fountains
I. Above grade swimming pools
J. Above grade kitchen areas

SUBSTRATE PREPARATION

A. Consult the membrane manufacturer for the maximum allowable moisture flow emanating from the substrate prior to application.
   1. Test the moisture flow with the calcium chloride test to determine the moisture flow per 1,000 square feet in 24 hours.
   2. If moisture flow is within allowable tolerances, apply membrane.
   3. If moisture flow is in excess of allowable tolerances, consult the membrane manufacturer for recommendations to reduce moisture flow to acceptable levels.
   4. Check with the membrane manufacturer for product limitations regulating pH levels and alkalinity.

B. Substrate should be prepared according to the membrane manufacturer's recommendations.
   1. Some membranes will crack if applied to substrates with irregularities such as gouges, holes or voids in the surface.
   2. Apply underlayment material to rid the substrate of irregularities.

C. Membrane should be installed over proper slope.
   1. If the proper slope to drains is not already established in the substrate, it should be established prior to the application of the membrane. Failure to slope the membrane results in moisture or water collecting in the mud bed or setting material, which can result in problems with mold, mildew, tile and grout discoloration, etc.

INSTALLATION

A. Use proper bond coat material when required.
   1. Some sheet applied waterproof membranes require specific materials to bond them to the substrate. Consult with the membrane manufacturer for specific recommendations. Do not substitute other materials that the membrane manufacturer has not specifically recommended.

B. Use reinforcing fabric when required by the manufacturer.
   1. Some waterproof membranes require a reinforcing fabric to be embedded in the membrane during application. When required, apply to 100% of the area being covered.
   2. Some membranes do not require reinforcing fabric in the field material but they may require special flashing kits to be used where changes of plane occur such as between the wall and floor or around protrusions. These flashing kits usually consist of a liquid and polyester mat or the polyester mat may be set into the waterproofing material in these critical areas. Failure to use the proper flashing material may result in cracking of the waterproof membrane.

C. Apply the waterproof membrane to the proper thickness.
   1. Manufacturers of liquid applied membranes may require application at different thicknesses depending on the performance requirements of different areas. Examples: Commercial areas versus residential areas. Read the manufacturer's printed instructions for thickness requirements.
   2. Some membranes may lose up to 1/2 their volume going from a liquid state to dry. This should be considered during application when trying to establish proper thickness per manufacturer's instructions.

TESTING FINISHED WORK

A. Waterproof membranes should be inspected as soon as possible after application to discover any pinholes or voids in the membrane. Application of more material to correct defects or replacement of some material may be required.

B. Water testing a waterproofing application should be conducted prior to application of any tile as it is very difficult to correct deficiencies once tile has been installed. Consult the manufacturer's instructions for the minimum curing time prior to water testing.

Photo courtesy of Merkrete Systems,
Tile contractor – City Tile & Stone

Slab On Ground Preparation and Precautions for Sheet and Liquid-Applied Crack-Isolation and Waterproofing Membranes

Tile contractors are often required to install sheet or liquid-applied Waterproofing and/or Crack-Isolation Membranes (WP/CIM) over slab on ground construction (SOG) before the installation of ceramic or natural stone tile.

The manufacturer's recommendations must be carefully followed in order to achieve a successful installation and to activate eligibility for the manufacturer's warranty. The installer is responsible for thoroughly understanding and following each manufacturer's requirement(s) and instructions for their products.

Curing compounds, sealers, curing accelerators and other surface bond-inhibiting contamination, including sweeping compounds, are prevalent on the SOG concrete. These will need to be evaluated and addressed before any W/P or CIM material can be applied. Slabs need to be well cured, dimensionally stable, and free of cracks, waxy or oily films and curing compounds. Concrete slabs must be adequately absorbent to accept water droplets. If water droplets bead on the concrete surface for more than 1 minute, contact your membrane manufacturer's representative because the slab may need to be profiled or treated per the membrane manufacturer's recommendations.

Some manufacturers may require Moisture Vapor Emission Rates (MVER) / Relative Humidity Rates (RH) before their underlayment and/or membranes can be applied.

If the concrete slab does not meet these criteria it may be necessary to discuss the matter with the general contractor or owner before proceeding.

Photo courtesy of Custom Building Products.



ACCELERATE YOUR SUCCESS

The National Tile Contractors Association has continually developed and maintained education and training programs consistent with rapidly-developing technology. For over 50 years, the association has played a major role in the professional installation of ceramic and stone tile and allied products as the category has grown. The National Tile Contractors Association and Ceramic Tile Education Foundation (CTEF) are committed to bringing you more training opportunities than ever before with NTCA Workshops, NTCA Regional Training events, NTCA University and CTEF classes and Certified Tile Installer testing.

175+
WORKSHOPS

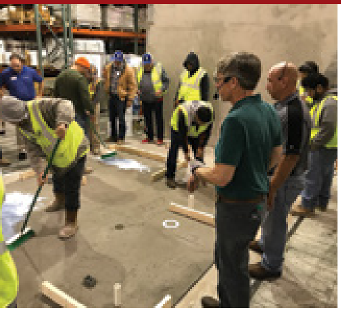
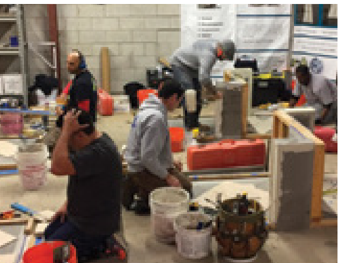
60+
REGIONAL TRAINING PROGRAMS

5,000+
NTCA UNIVERSITY COURSES

50+
CERTIFIED TILE INSTALLER (CTI) TESTING

For up-to-date information on events, training and testing locations visit NTCAtraining.com and CeramicTileFoundation.org.

WITH STANDARDS-BASED TRAINING


Self-Adhered Crack-Isolation and Sound-Control Membranes

Introduction

Cement based-grout etching/roughness, discoloration of grout, scale deposits on grout and tile, and deterioration of underlying thinset and mortar bed.

Self-adhered crack-isolation and sound-control membranes complying with ANSI A118.12, also known as Peel and Stick of self-adhered membranes, have become extremely popular in the tile industry as a solution to correct and prevent reflection of shrinkage cracks and control joint (movement) in concrete slabs through the tile assembly, as well as to control transmission of sound through tile assemblies. Self-adhered membranes have unique characteristics, such as extreme flexibility and self-adhesive qualities that make this type of membrane an efficient and cost effective problem solver for tile installations. However, these unique characteristics also make certain considerations, such as construction of tile movement joints and correction of concrete with excessive moisture, much more critical than in traditional installations where tile is adhered directly to a concrete substrate. Some of the special considerations and cautions are on the pages to follow. The membranes should not be to used in lieu of *TCNA Handbook* EJ171. Please note that per *TCNA Handbook* method F125, movement joints are required.

Photo courtesy of NAC Products Inc.

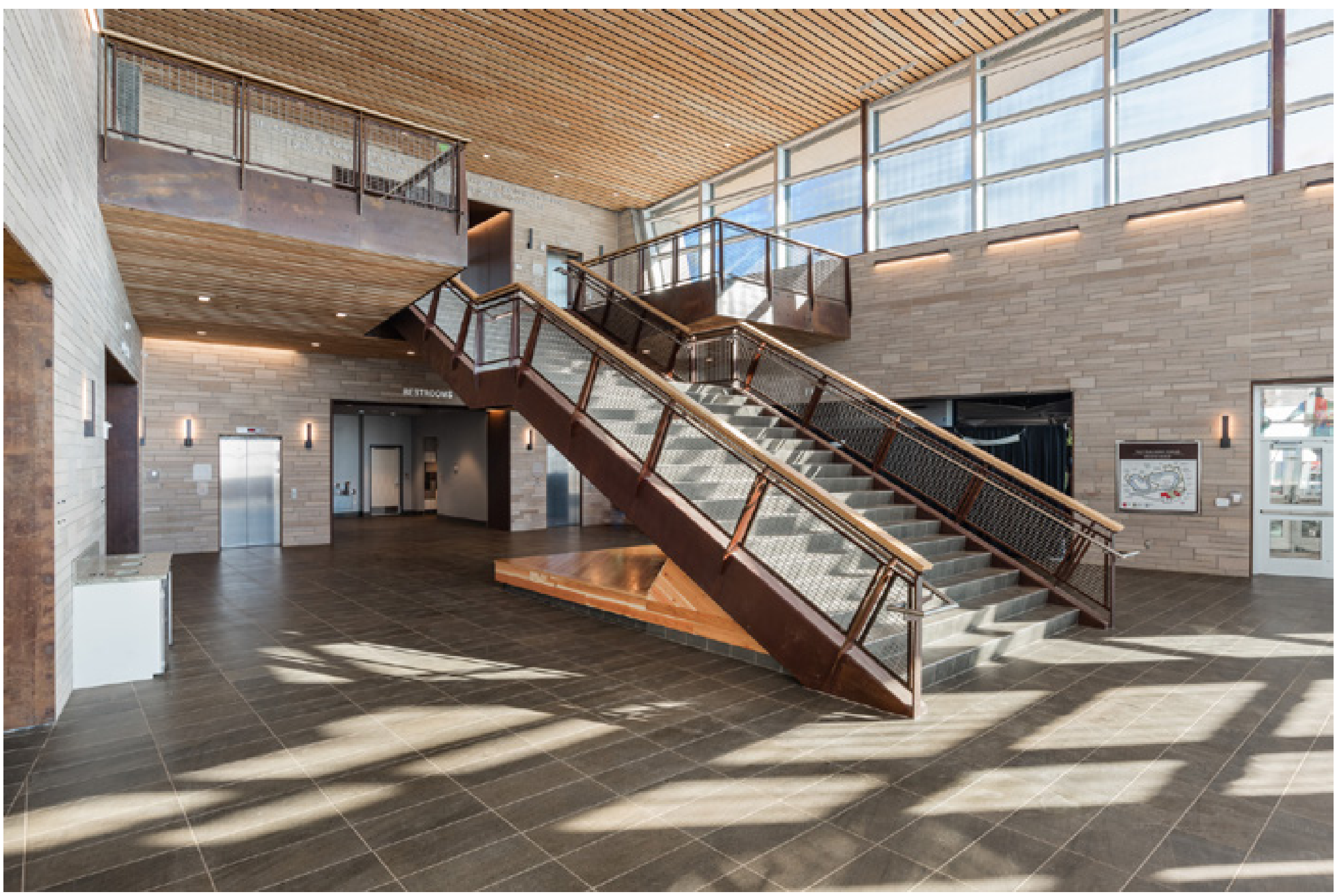


Photo courtesy of MAPEI Corporation

MOVEMENT – Movement joints are critical when installing tile over a flexible self-adhered sheet membrane, especially at perimeters and in the center field of tile, as tile will move more freely during shrinkage of mortars and concrete slabs. If installing tile and a membrane over a mortar bed or large areas of underlayments at 1/2 in. (13 mm) thickness or greater, place control joints in the mortar bed or underlayment no greater than 12 x 12 foot centers, with joints extending up to the tile surface. Mortar beds installed over membrane must be reinforced with wire mesh to control shrinkage, as the membrane does not restrain shrinkage movement of the mortar bed. See ANSI A108.1

Problem	Cause	Cure
Tile installed over membrane is loose, lifted, or has suspect hollow acoustic sounds.	Failure to provide adequate movement joints in the tile, especially at perimeter. Tile and mortars are allowed to expand and contract more freely when installed over a flexible membrane. (POSSIBLY DUE TO DEFLECTION, CREEP OR CURL)	Installation of movement (expansion) joints at perimeters and field of tile are mandatory when installing tile over membrane. Refer to *TCNA Handbook* EJ171.

OFFSET OF UNDERLYING CONTROL JOINTS – Tile layout typically does not allow alignment with underlying control joints in concrete slabs. When using membrane to offset control joints in a concrete slab, it is important to observe membrane manufacturer requirements for placement of movement (expansion) joints in the tile, the extent of membrane coverage required, and any requirements for cutting full coverage membrane installations to isolate stress on the membrane. See ANSI A108.17-6.0

Problem	Cause	Cure
Tile installed over membrane at or near control joints in the underlying concrete slab is loose, lifted, or has suspect hollow acoustic sounds.	Movement in underlying control joints is transferred to the membrane, and if tile is restrained, tile will lift upwards and cause loss of membrane adhesion.	Provide adequate movement joints in the tile directly adjacent to locations where tile/membrane bridges underlying concrete control joints. Refer to *TCNA Handbook* EJ171.

INCREASED CURE TIME OF ADHESIVE MORTARS – Membranes increase cure time for the majority of latex / polymer modified cement mortars by encapsulating moisture between the impervious tile and membrane. The encapsulated moisture could also affect moisture sensitive stone, or cause increased moisture expansion in more absorptive clay body tile.

Problem	Cause	Cure
PROBLEM 1 – Tile installed over membrane that is loose or damp, and removal of tile reveals mortar soft and damp. PROBLEM 2 – Clay bodied tile or natural stone tile is loose, lifted and has hollow acoustic sound.	Increased cure time of latex/polymer modified mortars and resulting residual moisture.	PREVENTION 1 – Allow additional cure time before opening to traffic or use fast-setting type mortars that use special cements that bind residual moisture. PREVENTION 2 – Test moisture sensitivity of natural stone or clay bodied tile prior to installation over membrane.

DETERIORATION OF MEMBRANE PRIMER ADHESION – When installing a membrane over concrete slabs, it is generally recommended, and required by some membrane manufacturers to test for pH and moisture vapor transmission through the concrete slab. Moisture that can accumulate beneath a membrane can deteriorate many of the primer products used to adhered membranes due to the high pH of damp concrete.

Problem	Cause	Cure
Tile installed over membrane is loose, lifted, or has suspect hollow acoustic sounds; when tile is removed, tile remains adhered to membrane, and membrane can be removed easily from the concrete; membrane primer may be soft and wet.	Elevated pH from the excessive moisture in concrete deteriorates membrane primer and adhesive interface of membrane.	Always conduct moisture vapor transmission testing on concrete slabs prior to installation of membrane. Check with membrane manufacturers for specific requirements. Some manufacturers require relative humidity to be <75% when tested according to ASTM F2170, (relative humidity test), or moisture vapor transmission to be below 3lb./1,000 sq. ft./24 hrs. when tested according to ASTM F1869 (calcium chloride test).

SHRINKAGE OF CEMENT MORTARS – Do not use thinset mortar in thickness greater than recommended by thinset product manufacturers or by industry standards (3/32-3/16 in. [2.4-4.8 mm]) thickness to install/level tile over membrane, as increased shrinkage of the thinset mortar may occur, which could exert stress on the membrane and result in loss of membrane adhesion. Large and Heavy Tile (LHT) mortar is typically formulated to control shrinkage when used from 3/16-3/4 in. (4.8-19 mm) thickness, and are acceptable for use over membranes.

Problem	Cause	Cure
Tile installed over membrane is lifted, or has suspect hollow acoustic sounds.	Improper use of cement based mortars; each type of mortar has thickness limitations based on formulation to control shrinkage.	Follow manufacturer and industry standard recommended guidelines for thickness of thinset and large and heavy tile (LHT) mortar. Provide wire reinforcing and control joints in thick-bed mortar installations to control shrinkage when installing tile over a membrane.

FLOWABLE HYDRAULIC CEMENT UNDERLAYMENT (FHU)/SELF-LEVELING UNDERLAYMENT (SLU) – As a general rule, do not install thin, flowable/self-leveling underlayments over membranes; level the substrate before installation of the membrane. Similarly, certain flowable/self-leveling underlayment products may also deteriorate due to sensitivity to moisture accumulation beneath a membrane. Always consult with FHU/SLU product manufacturer on this issue, as some products are not suitable for installation under membranes. FHU/SLU products typically undergo initial expansion and contraction while curing, and could crack or delaminate when installed over a flexible surface with an absorptive fabric scrim.

Problem	Cause	Cure
FHU/SLU product cracks or delaminates from membrane after installation.	Initial expansion and contraction of FHU/SLU while curing may cause cracking or delamination of FHU/SLU when installed over a flexible membrane; fabric scrim absorbs moisture and shrinks upon drying.	Do not install thin, self-leveling underlayments over membranes; level the substrate before installation of the membrane. Check with product manufacturers, as some special products are available if this application is necessary.

NARROW GROUT JOINTS – The minimum grout requirements for ceramic tile is 1/8 in. (3 mm) per ANSI A108.02 and for natural stone the minimum grout joint is 1/16 in. (2 mm) per Natural Stone Institute (NSI). It is even more critical when installing tile over membrane. These conditions apply regardless of whether membrane is used.

Problem	Cause	Cure
Grout is cracked or pushed out of joints; joint may be narrower than original installation; tile edges, especially soft stone tile, may be chipped.	Narrow grout joints provide no buffer to inward movement of the tile assembly when tile is installed over a flexible membrane; excessive inward movement often results from one of the above described errors.	Install joints per ANSI A108.02 when installing large tile; also follow above described guidelines to reduce potential for tile assembly movement found in *TCNA Handbook* EJ171.

Photo courtesy of the
National Tile Contractors Association

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THICK-BED METHOD INSTALLATIONS

Photo courtesy of Grazzini Brothers & Company
NTCA Five-Star Project of the Year Commercial
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Chapter 4
Thick-Bed Method Installation

Preparation for Thickset Installations per ANSI and *TCNA Handbook* Methods

Concrete Slabs ☐	Masonry Walls ☐	Stud Walls ☐
1. Mortar bed thickness to be uniform – 1-1/4 inches minimum to 2 inches maximum. 2. All slabs shall be clean, dry, structurally sound, and free of oily or waxy films. Slabs are to be free from oil, curing compounds, and laitances. 3. Slope, when required, is to be in the subfloor. 4. Maximum variation in the slab shall not exceed 1/4 inch in 10 feet from the plane required. 5. Give careful attention to the plans, specification requirements, and locations for expansion joints, control joints, and cold pour joints. Required joints should conform to the tile joint location.	1. Surfaces must be free of coatings: oil, wax, paint and block filler. 2. Poured-in-place concrete should be bush hammered or heavily sand blasted. 3. Maximum variation in the masonry surfaces shall not exceed 1/4 inch in 8 feet from the required plane. 4. Inside and outside corners are to be erected square and free of excess mortar.	1. Maximum variation in the plain of the studs shall not exceed 1/4 inch in 8 feet. 2. Metal or wood stud spacing is not to exceed 16 inches on center. 3. Minimum recommended metal stud depth is 3-5/8 inches. 4. Metal studs shall be 20 gauge (0.039 inches) or greater. 5. Adequate tie back bracing must be provided for stud walls exceeding 8 feet in height.

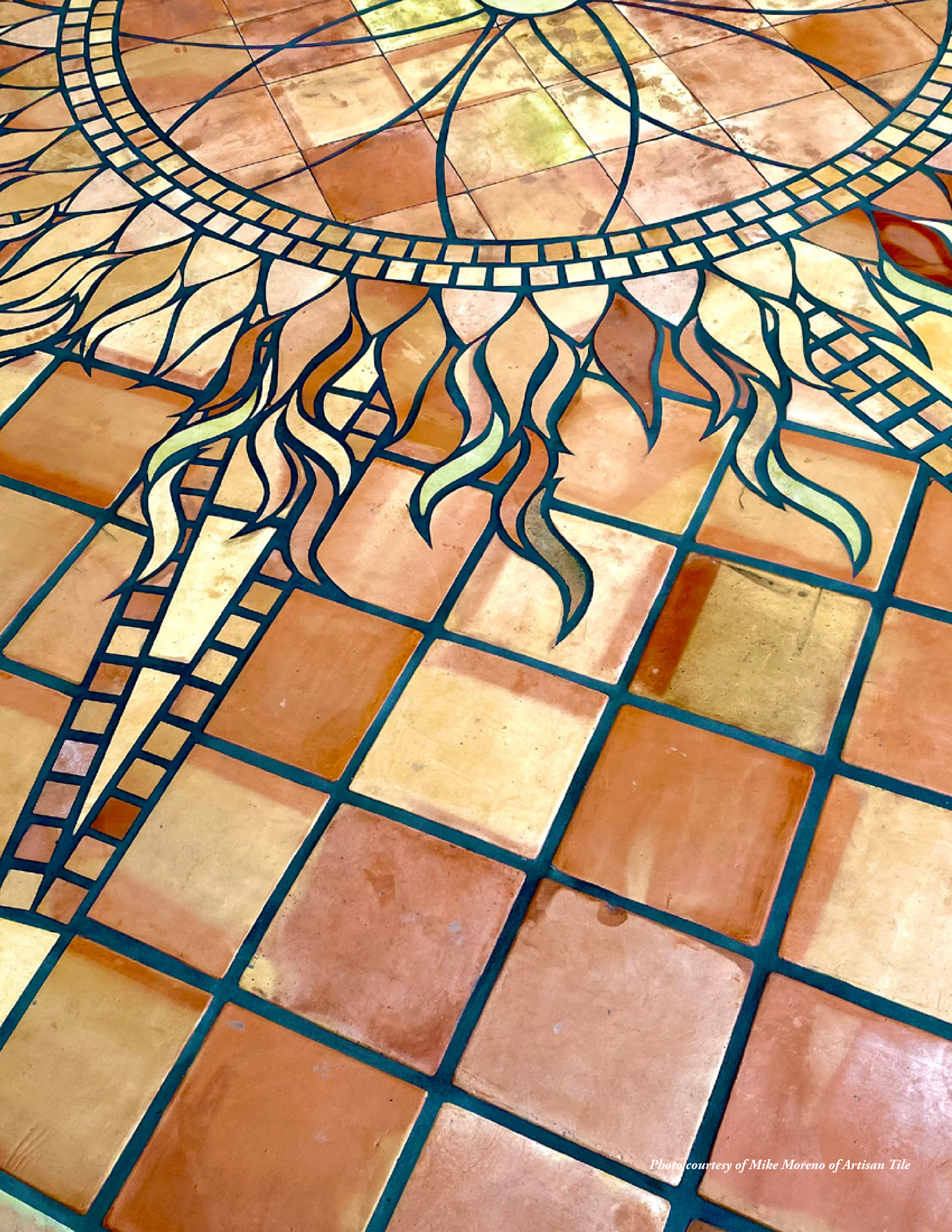


Photo courtesy of Mike Moreno of Artisan Tile

Mortar Beds

EXTERIOR PAVING

Mortar beds specified in ANSI A108.1 have at times experienced failures when used on exterior horizontal surfaces subject to freezing. In the 1960s and ’70s, TCNA conducted roof deck experiments with quarry tiles installed over sand and Portland cement mortar beds. In most instances, the mortar beds failed after exposure to freezing winters. Thus the Limitation in *TCNA Handbook* method F103 for Roof Deck; “although this is the best known method of installation for a ceramic tile roof deck, it is not reliable in areas where the mortar bed will be subject to freeze-thaw cycles.”

Whether used on roof decks, or slab-on-grade construction, when exposed to freezing conditions, standard sand and Portland cement mortar beds deteriorate to the point where the mortar beds are only sand. Depending on climate, the time for deterioration ranges from one to several years.

After only one freezing winter season, exterior tile installations begin to fail, with a few tiles becoming unbonded. Within two years most tiles may become unbonded. Under extreme conditions, such as found in the “freeze-thaw belt,” starting near Washington, D.C. and continuing north through New Jersey and New York, and running west to the Rocky Mountains, standard mortar beds turn to sand and tiles become unbonded.

These conditions are typically found on exterior mortar beds installed according to *TCNA Handbook* methods F101 and F103. When the drainage layer is omitted from roof deck installations, total failure frequently occurs during the first winter. Further south, to Atlanta, where the number of freeze-thaw cycles is minimal, failure may consist of delaminated tiles, and early deterioration of the upper and lower portions of the mortar beds, after one to two years.

Where mortar mixes consisting of one part Portland cement to only three parts sand and liquid latex are used for mixing, instead of water, mortar beds have fared much better under extreme freeze-thaw conditions. On one central New Jersey roof deck, tiles and latex-modified mortar beds were still intact after ten years, even though the drainage layer was omitted. The roof deck had excellent positive drainage to roof drains so water did not puddle on the surface or on the bottom of the mortar beds at the roof membrane. Roughly 1/8 inch of the lower portions of the mortar beds had deteriorated where water drained. The remainder of the mortar bed remained solid with no visible damage.

Although there are numerous cases of latex-modified mortar beds surviving harsh winter freeze-thaw conditions, testing in an independent laboratory, located in the “freeze-thaw belt,” needs to be undertaken to determine the real value of latex-modified mortar beds. Testing would require several years before results could be included in ANSI standards and the *TCNA Handbook*.

Installation of tiles and bond coat coverage is considered a separate subject. Proper/improper tile installation usually has little to do with mortar bed failures caused by freezing and thawing.

LATEX-MODIFIED MORTAR

Addition of latex to mortar mixes raises compressive strength and increases resistance to freezing and thawing damage. Latex, in varying strengths or concentrations, has been added to different mortar mixes for many years to produce stronger mortar. Again, there is misinformation concerning use of latex in mortar mixes, which states that the addition of latex to mortar mixes decreases the compressive strength. This is true for latex-modified thin-set mortars, which may use greater amounts of latex to make them “flexible,” and for some concrete mixes. However, for mortar beds used with tile work, addition of latex typically increases both compressive and tensile strength.

Usually, mortar mixes consisting of one part Portland cement, three parts dry sand and roughly five gallons of 18 to 19 percent solids latex per 90 pound bag of cement, produce mortar with compressive strengths ranging between 2,500 and 5,000 psi. (Level of compressive strength depends on compaction and curing conditions.) In addition to higher compressive strength, these mortar beds resist uneven shrinkage, curling and have excellent freeze-thaw resistance. They are typically used on exteriors in freezing climates and over floors requiring extra strength.

In addition to mortar mixes, latex is used in concrete road construction. There is a common phenomenon with this use. With the fresh concrete exposed to sun and a breeze, the surface dries quicker than the interior of the concrete. Under certain conditions, the surface will crack and curl like drying mud on a lake bed. This condition has been misinterpreted to relate to curling of latex-modified mortar beds.

Under certain conditions, latex-modified mortar beds will curl. When latex-mortar beds are installed in air-conditioned areas, they may experience curling at the edges because the air-conditioning removes moisture too rapidly from the surface. Covering with plastic usually eliminates curling under these curing conditions.

When damp sand is substituted for dry sand, water in the sand will replace part or most of the latex. Depending on how damp, or wet, the sand is, as much as 2-1/2 to 4-1/2 gallons of water can be contained in three hundred pounds of sand. With a normal three to one mix, three hundred pounds of sand is used with each 100 pound bag of cement, along with five gallons of liquid to make a workable mix. With wet sand described above, only 1/2 to 2-1/2 gallons of latex can be used, instead of the required five gallons.

This decrease in the amount of latex with a rich three to one mix ratio will cause excessive shrinkage in the mortar after it has been installed and screeded. Depending on temperature, humidity, wind/breeze and sunshine, (if the installation is outside or under skylights), the mortar may shrink enough to cause severe cracks around each separate screed area, and curling up to 1/4 inch across an eight to ten foot wide screed.

DAMP CURING

Normally latex-modified mortar does not require covering to instill damp curing. The surface latex cures quickly, creating a thin film that helps retain moisture in the mortar that aids in damp curing. However, under warm, breezy conditions, sprinkling the mortar with water after it is installed and covering with plastic is recommended. When damp sand is substituted for dry sand, damp curing is mandatory for latex-modified mortar beds.

Damp curing is also important for standard mortar beds. Damp curing increases compressive strength and produces a more dense mortar. Mortar beds as thin as 3/4 inch will cure harder when damp cured. Without damp curing, standard mortar beds, and even latex-modified mortar beds, may become soft and punky under adverse curing conditions. Curing conditions affect the compressive strength of cured mortar. Damp curing produces harder mortar with higher compressive strengths, whether they are standard mixes, or latex-modified.

INTERIOR FLOORS

There are ongoing problems with mortar beds, primarily on floors. Problems relate to workmanship, quality control, and a general lack of understanding on requirements for installing successful mortar beds.

The biggest area of concern deals with mortar mixes. These can be divided into two areas; one, mixing sand and cement. The other, sand-cement ratios.

Two methods of mixing are widely used in the industry. The first, and generally preferred, is use of a powered mortar mixer capable of mixing one bag of cement and various amounts of sand. Powered mortar mixers have been used on jobs of 200,000 square feet without any delays to those who were screeding the mortar beds.

Rototillers are used in many parts of the country to mix sand and cement placed on concrete floors near areas where mortar beds are being installed. This method can produce good quality mortar beds, but sand and cement must also be thoroughly turned over

with shovels so that materials on the bottom of the pile are properly mixed. With good quality control, mortar beds end up uniformly mixed with a minimum of pure sand spots, which weakens mortar.

Rich mixes, using one part Portland cement to three parts sand, typically create excessive shrinkage, which results in uneven shrinkage and curling or warping of the mortar. When bonded to a concrete slab, such rich mixes have a tendency to shrink more on the top side where moisture escapes faster, resulting in curled mortar that delaminates from concrete subfloors. Similar conditions occur when the mortar bed is placed over a cleavage membrane. Damp curing will help, but usually does not fully correct the curling problem. In addition, excessive shrinkage will cause cracks in the mortar.

There is misinformation and a lack of understanding on compressive strengths of mortar mixes and mortar beds. Typically, mortar mixes consisting of one part cement and five parts sand produce compressive strengths of 400 to 600 psi. Compressive strength can be increased with additional water, but wetter mortar is not screedable. When compacted in an ASTM cube, compressive strengths can be increased to 1,500 to 1,600 psi by more forceful compaction.

Also, compressive strength can be increased by compacting mortar as it is placed. Excessive compaction makes mortar difficult to screed. In addition, compaction in layers causes delamination between compacted layers.

There have been several instances where attempts have been made to reject standard mortar beds because compressive strengths ranged between 450 psi and 700 psi. The misinformation stated that these mortar beds should be in the range of 1,500 to 2,000 psi. It is unusual to achieve such high compressive strengths in the laboratory.

VERTICAL MORTAR BEDS

Generally, there are fewer problems with vertical mortar mixes and mortar beds. However, the following are avoidable problems.

Mixing mortar too rich can cause curling and shrinkage. Shrinkage results in shrinkage cracks that will crack or delaminate tiles.

Using fire clay instead of lime can cause delayed shrinkage that may cause mortar beds to delaminate from masonry backing walls, or tiles to delaminate from mortar beds.

Rich mortar mixes, such as one part cement to three or four parts sand, frequently cause excessive shrinkage in mortar. When shrinkage is excessive, mortar beds and tiles will crack along joints in metal lath. One part cement to four parts sand mortar beds typically cause cracking at horizontal metal lath joints when lath is installed over studs. Under adverse curing conditions, mortar beds may even develop random, spider web cracks.

Curing conditions also affect shrinkage of vertical mortar beds consisting of up to 5 or 6 parts sand. Dry, breezy conditions cause excessive shrinkage that can create cracks on horizontal joints between sheets of metal lath. On furring channels and metal studs walls, with mortar applied to only one side, excessive shrinkage will also cause the walls to bow.

Photo courtesy of Daltile

Photo courtesy of Lambert Tile and Stone 2023 NTCA Five-Star Project of the Year Residential Grand Prize winner

5

THIN-BED METHOD INSTALLATIONS

Photo courtesy of NTCA Member Basilica Tile of Virginia

Chapter 5
Thin-Bed Method Installation

NTCA Problem-Solving Guide
For Dry-Set Mortar Installations

Introduction

This guide addresses factory-prepared dry-set cement mortars, modified dry-set cement mortars and improved modified dry-set cement mortars only.

This guide is intended to offer possibilities for causes, characteristics of those causes, and prevention of dry-set mortar problems, and is to be used with the judgment and experience of the individual craftsman.

In all cases, users should refer to the manufacturers for their requirements and recommendations on the causes, characteristics, and prevention of dry-set mortar problems. The specific causes listed are common, but do not necessarily represent all problem areas.

Reference to proprietary products does not imply knowledge of compliance or non-compliance with industry methods, standards, specifications or codes.

This guide's reference to "Loss of Bond" concerns failures using dry-set cement mortars, sanded and unsanded; but the causes and characteristics also apply to modified dry-set cement mortars, improved modified dry-set cement mortars and EGP latex-portland cement mortars. **Information on "Modified Dry-Set Cement Mortars and Improved Modified Dry-Set Cement Mortars" is provided to deal with those conditions indigenous to polymer modified dry-set mortars**. Information on EGP Latex-Portland Cement Mortars is provided to deal with those conditions indigenous to latex portland cement mortars designed for bonding to exterior grade plywood. There is also information on "Exterior Installations" that covers special conditions encountered relative to climate.

In this guide, the assumption has been made that a bond failure has occurred, and offers suggestions for the causes of bond failure by offering common characteristics exhibited when specific causes are encountered.

NOTES

1. For the purpose of this guide, the term "plaster" will refer to Portland cement plaster or gypsum plaster.

2. Injection rebonding systems have been developed using epoxy and latex modified mortar. These systems provide a potential solution to some bond failures, however, they should be used only on the recommendation and specific application instructions of the manufacturer.

3. LARGE AND HEAVY TILE (LHT MORTAR) – Large and heavy tile (LHT mortar) was developed for the installation of larger sizes of ceramic, marble and granite type tiles. They are also recommended for the bonding of tiles with a more than average variance in thickness or warpage.

   The minimum thickness of 3/32 inch of dry-set mortar between tile and substrate, after proper bedding, is specified in ANSI. LHT dry-set mortars or LHT bed modified cement mortars shall be used in cementitious bond coats from 3/16 inch to 3/4 inch thick after the tile is embedded. Unless a mortar (thick) bed method is employed, the use of an LHT mortar is mandatory when setting tiles with ungauged thickness or when both of the following conditions exist:
   - **setting tiles with at least one side greater than 15 inches**
   - **where the final embedded thickness of the mortar will exceed 3/16 inch under the tile or stone.**

   LHT mortar should be considered with heavy tiles to minimize slump. LHT mortars are designed as direct bond adhesives and are not intended to be used in truing or leveling underlying substrates or the work of others. All substrate tolerances must be within industry standards. It is recommended that irregularities in the substrate greater than 1/8 inch out of plane in 10 feet be addressed with trowel applied or self-leveling underlayments prior to setting the tile. The method used to compensate for substrate irregularities should be determined and specified prior to bid. Contact mortar manufacturers for special installations.

   LHT mortars are intended to provide some additional thickness over standard dry-set mortars for tile irregularities. However, caution should be exercised in their use. Their increased thickness does not assure the installer of specified coverage nor the end of lippage problems, particularly on large size tiles. The practice of lifting tiles occasionally to check coverage should be observed. It should be noted that prying up tiles to check coverage while the mortar is still wet distorts the setting material and can exhibit a perception of better coverage than is actually being achieved, especially with larger unit tiles. It may be necessary to delay grouting of tiles installed with LHT mortars to allow for longer mortar curing time.

4. The uses of modified cement mortars are similar to those of dry-set mortars. Latex (or polymer) additives used in dry-set cement tile setting mortars are designed to improve adhesion, reduce water absorption and provide greater bond strength and resistance to shock and impact. These additives allow some latitude in time, working conditions, and temperatures. Therefore, modified dry-set cement mortar is required for the installation of large unit porcelain bodied tile unless other requirements are specified by manufacturers of other components in the system.


Photo courtesy of Ege Seramik

Proper Bedding Procedures

GENERAL
The use of proper bedding procedures is an integral part of successfully setting tile or stone and achieving the required minimum mortar coverage. Coverage is defined as a continuous dry mortar thickness ≥3/32" (2.38mm) between the substrate to the tile underside.

Acceptable coverage results can only be accomplished with proper surface preparation; using the correct size trowel; troweling technique; a tile placement method and adequate force to compact the mortar or adhesive. Different tile types, shapes and sizes require adjustments in the procedure to exceed the 80% minimum coverage for interior dry areas and the 95% minimum coverage rate for wet and exterior applications.

The bedding process involves four major requirements: (1) creating a bond to the substrate; (2) a bond between the tile and substrate; (3) a bond to the underside of the tile; and (4) assuring adequate support for tile edges. An excessive amount of voids as produced with spot bonding (see Spot Bonding pg. 303), leads to tile damage or bond loss due to deflection, impact, point loading, thermal and moisture changes.

For gauged tile and stone installations, substrate and tile flatness affects the bedding procedure. ANSI A108.02 requirements for tiles <15" on any side must meet a tolerance at ≤1/4" in 10' and no variation ≤1/16" in 12". For natural stone or large and heavy tiles (formerly referred to as large format tiles), the tolerance is ≤1/8" in 10' and no variation ≤1/16" in 24".

Tiles and substrates must be cleaned of contaminates prior to applying mortar. Tiles may arrive or become covered with construction dust; quarry dust, laitance, mold, kiln dust or pressing residues. Natural stone may have dried slurry from the fabrication process. Wiping the concrete, plywood or backerboard surface with a slightly damp sponge not only helps remove small particulates but can lower dryness and temperature thus improving mortar adhesion and open time.

MORTAR APPLICATION
Best results are obtained when mortar is firmly "keyed" into the substrate with the flat side of the trowel held at an angle. This step helps the mortar to create a bond to the substrate by filling in the surface profile. Right away, additional mortar is to be applied using the notched side of the trowel also at an angle to form ridges of similar height. The notched ridges should be combed uniformly in one direction. To assist with collapsing ridges and removing air, comb the notches perpendicular to the long edges of rectangular tiles. *(See page 167 Bonding Large-Sized Tiles)* Tile is then forcefully moved side to side perpendicularly across the ridges to collapse them fully and evenly. Based on the tile and trowel dimensions, the side to side movement will vary, typically 1/8"-3/4". Tile can be made flat to each other using a beating block and/or rubber hammer if necessary, especially when wet-setting into a mortar bed. Remove a tile periodically to assure you are achieving proper coverage and edges are supported.

Using the appropriate trowel *(see page 161 Trowel Guidelines)* may achieve adequate coverage but note that tile undersides of all sizes may have cavities or a rough profile; or be warped to a degree that will prevent adequate coverage. If the trowel does not account for this extra space, the space will require pre-filling or flat back-troweling *(see page 162 Flat Back-troweling and Notched Back-troweling [formerly Backbuttering])* with mortar just prior to being set into the troweled mortar on the substrate.

SPECIFIC TILE BEDDING METHODS

LARGE-AND-HEAVY-TILE COVERAGE
Due to the large areas covered by some individual tiles, it is more difficult to handle and place these formats. Flat back-troweling large manufactured and natural stone tiles is recommended to improve bonding and achieve minimum recommended coverage. **NOTE:** *The mortar coverage standard at this time is 80% for interior dry applications, but there are an increasing number of specifications calling for 90-95% coverage due to the high percentage of allowed space. Example: A 12"x24" tile is 288 sq. in. with 80% coverage allows for 57 sq. in. voids.*

QUARRY, PAVERS, AND NATURAL STONE
Quarry tile and pavers can present unique challenges to achieve proper embedment. They are often set with racks and this process can make it more difficult to slide the tiles adequately and ensure a proper collapse of the thin-set ridges. When using a rack to slide the tiles back and forth, a lot of force will be necessary. Always follow proper bedding procedures when installing quarry or pavers, even when using a beating block or tapping the individual tiles with a rubber mallet.

Natural stone comes in many different types, shapes, thicknesses and sizes. Keep the following key items in mind for proper embedment of thin-set mortar. Make sure to thoroughly clean the back of the stone tiles to remove any quarry dust or contaminants. Keying the thin-set mortar into the substrate and the backside of each piece is a very important step to ensure proper adhesion. The surface profile on the backside of the stone tiles can vary depending on the type of quarrying process used. Some cleft stone materials have ground backs that provide a coarse and uneven surface. For some large format sizes and irregular thicknesses, it is important to pull each piece away from substrate and visually examine the mortar to ensure the proper amount of mortar contact was achieved. It may necessary to add more mortar to any places where good contact was not made. To apply mortar to ungauged stones for an overall consistent thickness, a box screed may be used. *(See Box Screed page 160.)*

Photo courtesy of Bostik

SMALL MOSAIC TILES

Installing small mosaics, keeping them flat and having enough mortar under them, without the mortar coming into or through the grout joint, can be a challenging endeavor.

The following method can help with all of these issues:

First, key the mortar into the substrate using the flat side of the trowel. You will find that the notched trowel for this procedure to be deeper than you may think or expect. Next, trowel out the mortar leaving a uniform amount of material, and trowel it out several inches beyond where your first sheet will stop. Always trowel in one direction. Then, using the flat side of the trowel or a broad knife, knock the ridges down to a consistent level without picking up any excess material. Then set the first sheet of tiles onto the flattened mortar in its designated location and "gently" beat in the tiles with a flat wood beating block or flat rubber float.

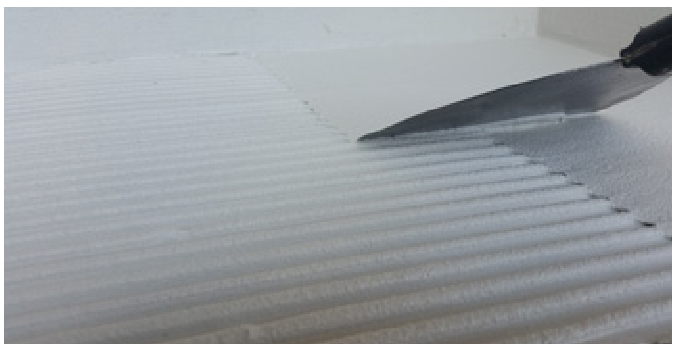


Photo #1 shows the ridges being knocked down with a broad knife.

Photo #2 shows a thin glass mosaic that is being set and beat in.

Photo #3 shows re-notching the previously flattened mortar to keep it fresh.

Contrary to beating in large tiles, the small mosaics require a gentler approach. Remember the size of the tiles that you are working with. Because there are no ridges to collapse, gently beating in the tiles with the flat block or float will properly embed the tiles. When you can see that the mortar is starting to protrude up into the grout joint you should have good coverage. Lift an edge of the sheet to see that you have good coverage. If the mortar is protruding up out of the joint, you are beating in too hard. These are small delicate tiles. You will get used to a gentler touch with practice.

Now continue to trowel out mortar, re-notching the previously flattened mortar next to your previous installed sheet and re-flatten. This process will assure that the mortar is still keyed into the substrate, always fresh and will not skin over. Continue to set your sheets. As you beat in the next sheet have a portion of your block transfer from the previous sheet, beating in two sheets at once. This will keep the top of the tiles on plane and not tipping.

The trowel size will be determined by the thickness of the tile and the texture on the back of the tile. Some glass tiles have a cavity on the underside that will require more mortar in order to get proper coverage.

With every tile, always use the proper size trowel in order to get the proper coverage needed after beat in.

GLASS TILE COVERAGE

PAPER-FACED GLASS MOSAICS

Paper face mounted mosaics are manufactured so that you get the most mortar coverage on the back of the tiles when they are installed. Because they are face mounted, they are easier to adjust after they are installed.

Before starting your installation, check the sheets for size from one to the other. Because you can only see the perimeter of the sheets from the front, check the back of the sheets and check to see that the tiles are mounted square and/or correctly. If there are pieces that do not line up with others they will need to be adjusted later, or cut them out now and install them after you have removed the paper. Lay out several sheets on a flat surface in order to determine that the sheets line up from one to another.

When installing these tiles follow the same procedure as the "Small Mosaic Tiles" procedure.

After the tiles are "beat in" and have a chance to set, 5-30 minutes depending on the mortar type and substrate, you will need to wet the paper so that the glue emulsifies and can be removed. Use a wet sponge or spray bottle to gently wet the paper with water. The "soaking" of the paper will take several applications before the glue will emulsify and let loose from the tiles. Do not use too much water as it may get into the mortar. Between applications of water you will notice the paper is starting to turn dark. The darker

Photo courtesy of
NTCA Five-Star Contractor J&R Tile

the paper gets the easier it will be to remove it. You will also notice that the outer edges of the paper are turning lighter faster as they are drying out. Keep them moist as they are drying out faster. When all of the paper has turn dark, take hold of a corner of the paper and gently pull it off of the tile. If it doesn't release from the tiles continue to soak the paper until it does. The paper should release and be removed as a single sheet of paper. After the paper has been removed, gently wash the tile surface with clean water to remove any excess glue from the paper. If need be the remaining glue can be washed off the next day. At this time, check the tiles and adjust any that may have moved during the paper removal processes.

Note: Cutting a full sheet of paper face mounted tile on a regular wet saw is not recommended as the water from the saw will start to emulsify the glue from the paper and the sheet may start to fall apart.

As an alternate method for paper-faced mosaics, certain non-sanded cement grouts mixed with adhesive latex admixtures may be used as both the adhesive and grout. In this application method, the liquid to powder ratios are measured and replicated to create a consistent color. The glass tile is grouted from the underside while adhered to the paper and while wet, placed onto the mortar applied to the substrate in the manner described above. The sheet tiles are beat into place and paper is to be removed after an initial set. Perform a mockup to confirm color and appearance

OTHER GLASS TILE FORMATS

Glass tiles formed in dimensions >9 square inches can be adhered with mortars based on manufacturers' recommendations and possible testing. They may alternatively require special adhesives such as epoxies, silicones or urethanes. Bedding methods would be similar to mortar application procedures

GAUGED PORCELAIN TILE AND GAUGED PORCELAIN TILE PANELS/SLABS COVERAGE

Due to the large sizes of these products traditional notched trowels employing a traditional approach of pressing and sliding will not adequately facilitate and achieve the necessary ridge collapse to achieve the required coverage. It is required to use a trowel configuration that is designed to facilitate bonding mortar ridge collapse.

Scratch/key the mortar into the substrate and gauged porcelain tile or gauged porcelain tile panel/slab with the flat side of the trowel before combing.

Using a notched trowel of type and size recommended by mortar and tile manufacturers, comb mortar onto substrate and tile uniformly with no bare spots.

Mortar ridges on both the gauged porcelain tile and gauged porcelain tile panel/slab back and on the substrate must be parallel to each other, combing at right angles (perpendicular) to the long side of the tile panel/slab. Use the appropriate trowels and troweling technique (hold at least a constant 45° angle) and take care to keep the ridges straight and of consistent height. This is crucial to achieving required coverage.

Overspread the mortar on the substrate by at least an inch wider than the gauged porcelain tiles or gauged porcelain tile/slab you plan to embed. This is to ensure full support of mortar at the tile edges and corners.

When troweling mortar on the back of the gauged porcelain tile or gauged porcelain tile panel/slab, complete edge to edge coverage of the mortar is required in order to achieve continuous support of edges and corners once embedded.

Troweling techniques are critical in creating an even setting bed to ensure an adequate and uniform bond coat between gauged porcelain tiles or gauged porcelain tile panels/slabs and substrate. Therefore, it is recommended when troweling gauged porcelain tiles and gauged porcelain tile panels/slabs with widths greater than 20 inches (0.5 m) to comb the mortar on the tile from the center line to the outside edge. Leaving this start/stop point at the centerline of the tile will ensure a uniform setting bed of mortar under the tile body and that the edges of the tile are fully supported.

Do not allow mortar to skin over or exceed the mortar's open time. Trowel over an area no greater than can be covered with tile before the mortar skins over.

On both floors and walls the resulting embedded mortar layer shall have a minimum thickness of no less than 3/16 in. (4.8 mm).

Photo courtesy of LATICRETE International

Loss of Bond

Dry-set mortar adheres to tile but not to substrate

Problem	Cause	Cure
Dust or dirt embedded in dry-set and/or on substrate.	Dust or dirt on substrate.	Properly clean substrate prior to application of dry-set mortar.
Dry-set mortar releases from the substrate completely where curing compounds or release agents are present. Water will not penetrate into slab or, if compound or agent has transferred to the dry-set, water will not penetrate into dry-set mortar. Visible evidence rarely appears on substrate.	Curing compounds or release agents on surface of concrete.	Properly test for curing compounds or release agents prior to installation. Refer to "Curing Compounds, Release Agents, and Sweeping Compounds" (page 26) for proper testing and removal methods. Precast, preformed, or prestressed concrete should always be tested for curing compounds or release agents.
Portions of cement plaster may be embedded in dry-set mortar. If plaster mix is too rich, excess shrinkage results, causing entire sections of tile to bow away from wall.	**Weak Substrates** – Improperly mixed Portland cement plaster.	Use correct proportions of materials and amount of water. Apply and cure in accordance with proper procedures.
Failure usually occurs at interface of dry-set mortar and gypsum or lime-based substrate. Particles of the substrate are usually found on back of dry-set mortar or on surface of substrate. In some cases, where structural movement has taken place, fractures may occur deep within these substrates, indicating the inherent weakness of this type of substrate, instead of deterioration caused by water.	**Inappropriate or Unacceptable Substrates** – Gypsum plaster, lime putty coat, light-weight concrete, gypsum underlayment, or gypsum taping compound.	Direct bond dry-set mortar installations over gypsum-based substrates are not an accepted practice of the industry due to the potential formation of ettringite. Gypsum and lime putty are very sensitive to moisture. Even the amount of water contained in dry-set mortar during application is enough to cause deterioration of the substrate. Check with setting material manufacturers for primer and/or membrane recommendations for gypsum substrates.
Failure occurs soon after installation. Bond failure can occur at any point, from interface of dry-set to rupture of tile bisque.	**Unacceptable Substrates** – Lath and plaster applied to metal studs that are too thin, improperly spaced or anchored or improperly crossbraced.	Metal studs shall conform to ASTM, C–645. Refer to *TCNA Handbook* W241. Stud spacing not to exceed 16 inches on center. Minimum stud width 3-5/8 inch. Studs shall be 20 gauge or heavier and properly anchored. Substrate shall conform to ANSI deflection requirements. Horizontal bridging (crossbracing) 4 feet on center may be needed.
Dry-set mortar separates from the substrate, showing evidence that the mortar was not forced into the substrate surface.	Setting material not properly applied to achieve mechanical bond to the substrate.	First, key the dry-set mortar into the substrate with flat side of trowel. Add mortar as required to achieve required thickness then comb with the notched side of the trowel in one direction. Comb only an amount where application of tile can take place before skinning occurs. Refer to “Proper Bedding Procedure” on page 116 for additional information.

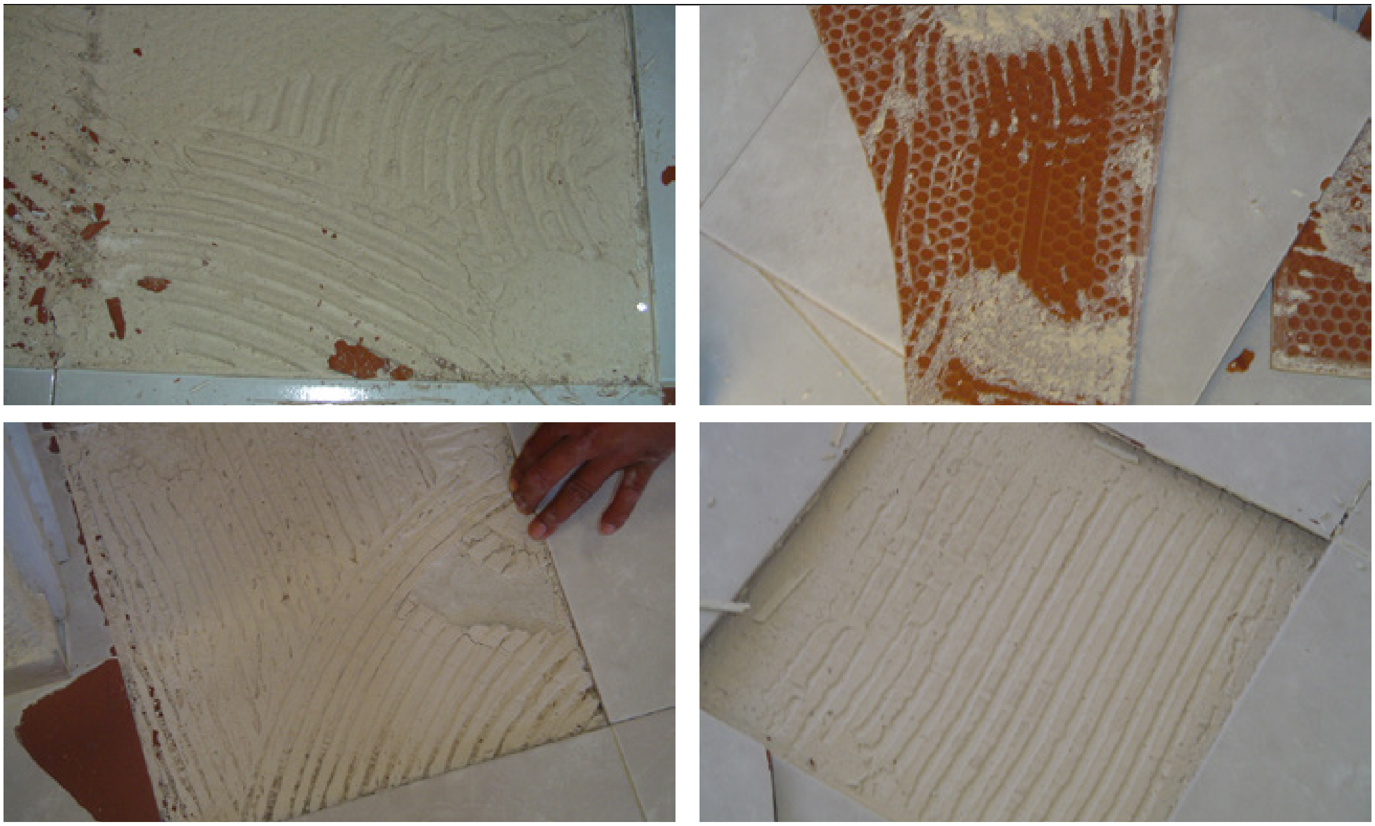
Loss of Bond ***(Dry-set mortar adheres to tile but not to substrate)***

Problem	Cause	Cure
Dry-set mortar separates from the substrate	Oil or wax based sweeping compounds used	Mechanically remove to clean concrete
Dry-set mortar releases (clean shear) from the surface of the waterproofing.	Waterproof materials not compatible with the dry-set mortar.	Dry-set mortar application over waterproofing requires strict adherence to manufacturer's instructions. Have the manufacturer confirm the compatibility of the materials.
Flash set or rapid evaporation of water causes dry-set to be weak at substrate interface, resulting in release from substrate.	Substrate too hot, causing flash set of mortar.	In hot weather conditions, mix dry-set mortar with cool water. Dampen substrate prior to application of dry-set mortar. Apply dry-set mortar with flat side of trowel and notch just before tile is applied. Take special precautions to retain the moisture in setting materials applied over substrates heated by the sun, radiant heat, etc.
Dry-set mortar separates from the substrate with very little residue of dry-set mortar remaining on the concrete.	Concrete substrate burnished during the finishing process providing little porosity at the surface for a mechanical bond.	Burnished concrete must be scarified to open pores of the concrete to achieve sufficient bond of the dry-set mortar.
Dry-set mortar separates from the substrate; can exhibit cracking within the dry-set. May leave dry-set residue on substrate.	Dry-set mortar applied in excess of thickness limitations inducing excessive shrinkage during curing.	Dry-set mortars that are not designed as large and heavy mortars are limited to 1/4” in thickness between the back of tile and the substrate.
Bond failure may occur at any interface and within matrix of dry-set mortar. Mortar is weak and crumbles.	Dry-set mortar freezes before curing.	Maintain substrate and ambient air temperature above freezing per the manufacturer recommendations. Fast-setting latex dry-set mortars may offer superior performance. Consult the manufacturer.
Bond can fail at either interface or within the matrix of the dry-set. Dry-set is weak and has signs of air entrainment.	Mixing with high speed drill, over mixing or using improper mixing wand will entrain air and substantially weaken the dry-set mortar.	Use mixing drill at or below 300 RPM. Use mixing wand designed for dry-set mortars. Follow manufacturer’s directions for mixing water or additive and mixing times

Loss of Bond

Dry-set mortar adheres to substrate but not to tile

Problem	Cause	Cure
Tile comes off clean or has small residue of dry-set indicating little contact with dry-set mortar.	Improper trowel used, causing insufficient material to be applied. Contamination on back of tile.	ANSI A108.5 requires 80 percent coverage of dry-set on back of tile except exterior and wet areas, where 95 percent coverage is required. Refer to "Trowel Guidelines" on page 161.
Trowel ridges are clearly visible and/or imprint of tile shows in mortar. Tile can come off completely clean or show traces of dry-set where ridges contacted tile, but skinning prohibited bonding.	Dry-set mortar allowed to skin over prior to application of tile. Proper bedding did not rupture the skin.	First, apply dry-set mortar with flat side of trowel. Then, notch only an amount where application of tile can take place before skinning occurs. Refer to "Proper Bedding Procedures" on page 116 for additional information.
Dry-set mortar separates from the substrate; can exhibit cracking within the dry-set. May leave dry-set residue on substrate.	Dry-set mortar applied in excess of thickness limitations inducing excessive shrinkage during curing.	Dry-set mortars that are not designed as large and heavy mortars are limited to 1/4" in thickness between the back of tile and the substrate.
Tile comes off clean. White residue from release agent used during manufacturing present on back of tile or embedded in dry-set.	Excessive release agent on back of tile.	Tiles exhibiting powdery substance on back of tile must be washed with clean water and a brush to remove free release agent prior to setting tile.
1. Mortar is weak and powdery. 2. Mortar shows signs of sagging, slumping, or running.	Too much water used to mix dry-set mortar.	Properly mixed and slaked dry-set mortar should always hold ridges of trowel after application. Correct consistency is indicated when properly prepared dry-set mortar will cling to the bottom side of a margin trowel and will not run off.
Dry-set mortar releases from tile, leaving residue on back of tile. Dry-set may be weak and brittle.	Weather, substrate, water, or tiles too hot causing dry-set mortar to flash set.	In hot weather conditions, mix dry-set mortar with cool water. Slaking is very important. Dampen substrate prior to application. First, apply dry-set with flat side of trowel. Then, notch just before tile is applied. Give special attention to storage of tile and other materials in cool conditions. Use extreme caution when installing tile when temperature is over 90° F. When temperatures exceed 90° F use specially formulated high temperature mortar.
Tiles come off mortar bed clean or with light residue of dry-set mortar.	Dry-set mortar used as dry sprinkle over mortar bed, instead of Portland cement. Contamination on back of tile.	Dry-set mortar must be mixed and applied according to directions. The chemicals in dry-set mortar do not function unless properly mixed prior to application.
Bond failure may occur at any interface and within matrix of dry-set mortar. Mortar is weak and crumbles.	Dry-set mortar freezes before curing.	Maintain substrate and ambient air temperature above freezing. Fast-setting latex dry-set mortars may offer superior performance. Consult the manufacturer.



Thinset bond defective install. Photos courtesy of Dave Gobis.

Loss of Bond ***(Dry-set mortar adheres to substrate but not to tile)***

Problem	Cause	Cure
Failure will occur at the weakest point. Entire sections of the tile may crack and/or arch away from substrate.	Movement of substrate. • Shrinkage • Deflection • Thermal movement • Tiling directly over expansion joint	Consider setting method F111 of *TCNA Handbook*. Adhere strictly to *TCNA Handbook* – Expansion Joint Details, EJ171, and to ANSI Specification A108.01.3.0; Related Work Specified In Other Sections. If details on plans or specifications do not call for expansion joints or control joints, the architect should be notified of the ANSI Expansion Joint Requirements. If the architect still does not specify expansion joints, the tile contractor should initiate a letter of release of liability. **The tile contractor should not assume responsibility for the design and location of expansion joints.**
When loose tiles are removed, wetting cementitious surfaces with water or ink solution will assist in detecting cracks.	Structural movement in substrate.	Closely inspect the substrate prior to installation of tile. For cementitious surfaces, dampening with water may help in detecting cracks. If structural movement is anticipated, the *TCNA Handbook* Installation Method F111, or a manufacturer's elastomeric membrane system should be used. The architect should specify proper expansion joint location and design. Substrate shall conform to ANSI A108.01.2.3 deflection requirements.
Bond can fail at either interface or within the matrix of the dry-set. Dry-set is weak and has signs of air entrainment.	Mixing with high speed drill, over mixing or using improper mixing wand will entrain air and substantially weaken the dry-set mortar.	Use mixing drill at or below 300 RPM. Use mixing wand designed for dry-set mortars. Follow manufacturer's directions for mixing water or additive and mixing times.


Photo courtesy of
New Ravenna

Loss of Bond

Dry-set mortar fractures within bonding material – mortar on tile and substrate

Problem	Cause	Cure
Dry-set mortar is present on both tile and substrate. Bond failure occurs near the mid-point of dry-set mortar. Normally, there is no evidence of a powdery cement where the bond is broken.	Vibration or shock before dry-set mortar was cured. Traffic allowed on floor prior to curing of dry-set mortar.	Prevent all trades from disturbing the installation during the curing cycle. Under normal conditions, light foot traffic can be allowed after 48 hours. Heavy traffic must be kept off floor at least 72 hours unless special, fast-setting dry-set mortars have been used. Cold temperatures, 50° F or below, will slow the curing process.
Dry-set mortar is weak and powders easily; and may show evidence of shrinkage cracks.	Dry-set mortar retempered with water.	Never add water to dry-set mortar if it has stiffened beyond the point of usage. Discard old material and mix fresh dry-set mortar.
Mortar is crumbly. Failure can occur at any point.	Freeze/thaw.	Protect from freezing. Maintain substrate and ambient air temperature above freezing. Rapid-setting latex dry-set mortars may offer superior performance. Consult the manufacturer.
Bond to substrate and to tile. Center of mortar is weak and powdery.	Rapid water loss to substrate and tile.	Soak tile. Dampen substrate. Control loss of moisture in high temperature and/or windy conditions.
Failure will occur at the weakest point. Sometimes entire sections of the tile will crack and/or arch away from the substrate.	Thermal expansion and contraction.	Consider setting method F111 of *TCNA Handbook*. Adhere strictly to *TCNA Handbook* – Expansion Joint Details, EJ171, and to ANSI Specifications A108.01.3.0; Related Work Specified In Other Sections. If details on plans or specifications do not call for expansion joints or control joints, the architect should be notified of the ANSI Expansion Joint Requirements. If the architect still does not specify expansion joints, the tile contractor should initiate a letter of release of liability. **The tile contractor should not assume responsibility for the design and location of expansion joints.**
Bond can fail at either interface or within the matrix of the dry-set. Dry-set is weak and has signs of air entrainment.	Mixing with high speed drill, over mixing or using improper mixing wand will entrain air and substantially weaken the dry-set mortar.	Use mixing drill at or below 300 RPM. Use mixing wand designed for dry-set mortars. Follow manufacturer's directions for mixing times.

Loss of Bond

Bond failure on exterior installations

Problem	Cause	Cure
Tile comes off clean, or with a small residue of dry-set mortar where ridges in dry-set mortar were in contact with tile.	Full coverage not obtained between dry-set mortar and tile, or dry-set mortar and substrate. Water penetrates and collects in voids, and upon freezing, forces tile to lose bond.	At least 95 percent coverage must be obtained between tile, dry-set mortar, and substrate in accordance with ANSI A108.5 on exterior installations, which requires 3/32 inch minimum thickness of bonding material and proper bedding.
Failure will occur at the weakest point. Sometimes, entire sections of tile will crack and/or arch away from substrate. If expansion or contraction occurs during the curing cycle of the dry-set mortar, bond failure may occur within the matrix of the dry-set mortar. If curing of the dry-set mortar is complete and a good bond is obtained, failure will occur at the weakest interface, i.e. either at the substrate or at the tile.	Lack of movement joints. Heat or cold, causing expansion and contraction of tile and substrate, create pressures that overcome the bonding strength of the setting material.	Consider setting method F111 of *TCNA Handbook*. Adhere strictly to *TCNA Handbook* – Expansion Joint Details, and to ANSI Specifications A108.01.3.0; Related Work Specified In Other Sections. If details on plans or specifications do not call for expansion joints, the architect should be notified of the ANSI Expansion Joint Requirements. If the architect still does not specify expansion joints, the tile contractor should initiate a letter of release of liability. **The tile contractor should not assume responsibility for the design and location of expansion joints.** Also, use a modified or improved dry-set mortar to assist in bonding when slight thermal movement is anticipated.

Notes:

1. Polymer modification is required for all exterior mortar installations unless other requirements are specified by manufacturers of other components in the system.
2. Exterior installation with epoxy should be done only with the approval of the manufacturer.

Tenting

Problem	Cause	Cure
"Tenting," commonly observed as unbonded tiles elevated above their originally bonded position, is caused by a variety of situations. This situation can occur in all tile installations, but is often encountered in installations of porcelain tile set with dry-set mortar in a thin-set manner. The low bond strength of the mortar to the porcelain tile, relatively low flexibility of dry-set mortars, the thin cross section of the installation and specific substrate conditions, may combine to produce detrimental effects. Listed below are the more frequent causes of "tenting" along with their respective reasons and preventive measures.		
Setting directly over movement joints.	Lateral movement causes a weakened or total loss of bond when the dry-set, latex Portland cement, or EGP mortars have been applied over and subsequently fill the existing movement joints. These joints now become restricted in their movement capabilities resulting in buckling, cracking and/or other detrimental effects to the tile installation.	Follow ANSI and *TCNA Handbook* recommendations for properly constructing and treating movement joints.
Shrinkage of concrete slab.  *Lack of movement joints will cause pressure to build up and result in tenting of tile.*	Young (uncured) concrete will exhibit a reduction of surface area during its curing stage. The degree of shrinkage is mostly a function of the amount of water used during mixing – the more water, the more shrinkage. When tiles are applied to green concrete they immediately are subjected to counteracting stresses. These stresses result from the concrete reducing in surface area and the tile maintaining its original dimensional characteristics. Therefore, the weakest link of the system, the bonding mortar, fractures and the tiles separate from the concrete slab. Because the directional stresses are more concentrated towards the center of the slab, tiles in this area loosen first and further delamination continues at a reduced rate towards the perimeter. The tiles that are still bonded along the perimeter areas now pinch inward, causing the center tiles to lift upward.	Allow the concrete slab to cure at least 28 days, but preferably longer. Lower temperatures and high humidity will extend the curing time. Check with membrane manufacturers for crack-isolation membrane options and concrete moisture limitations.

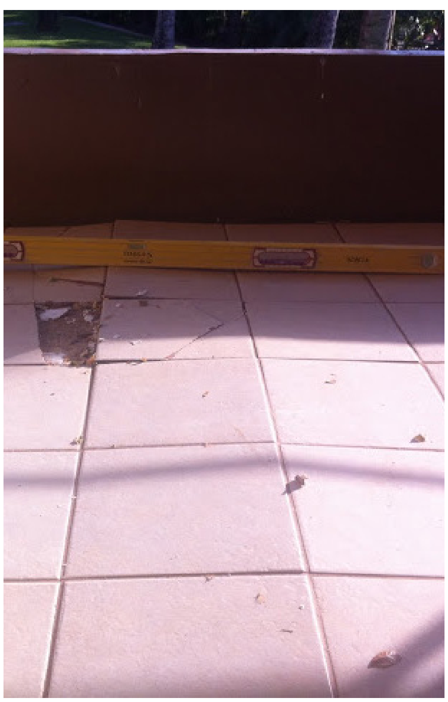
Problem	Cause	Cure
Not enough or no movement joints.	The purpose of expansion/control joints is to allow movement of concrete and/or masonry substrates, without cracking. By dividing a large concrete or masonry expanse into separate, smaller units the overall stresses are minimized by distributing them more evenly throughout the area. These smaller areas now work independently and move at a much lower rate. Each unit is also sealed along the entire perimeter with an elastomeric sealant, which acts as a shock absorber, by stretching and compressing.	Assure that movement joints are included in drawings and positioned in accordance with ANSI and *TCNA Handbook* recommendations. When in doubt, suggest using more than required, which will result in shorter distances between the joints. Accommodate for movement in the perimeter of the installation by placing a soft joint in lieu of grout or tile.
Thin setting directly over structural slabs.	Elevated structural concrete slabs are designed to deflect over time and when live loads are applied. This downward movement causes a change in the surface dimension of the slab. The dry-set, latex Portland cement or EGP mortar now fractures due to the stresses caused by the deflecting structural concrete slab. Loose tiles then lift or "tent" above the deflected floor areas.	Follow ANSI and *TCNA Handbook* recommendations for properly constructing and treating movement joints.
Differential movement and structural settling.  *Expansion and contraction due to climate conditions, without adequate movement accommodation, can result in tile tenting.*	Differential movement is the result of the varying degrees of movement between dissimilar construction products. This movement is caused by changes in moisture, temperature and in some cases settling. Since each dissimilar component will move at a different rate, stresses will develop that may be detrimental to the tile installation. Examples of different building products commonly used together in tile installations are plywood, steel and wood studs, cementitious and gypsum backerboards.	**Climate controlled conditions:** Allow components to stabilize, by running the climate control system and maintaining normal humidity and temperature levels for several days. Then follow ANSI and *TCNA Handbook* anti-fracture/crack suppression recommendations for the movement joints and tile installation. **Non climate controlled areas:** Follow ANSI and *TCNA Handbook* movement joint recommendations. Crack-isolation systems should also be considered for this situation.

Photo courtesy of Dragonfly Tile & Stone Works for the NTCA and LATICRETE co-sponsored Artisan Revolution in Training (A.R.T.) event.

6

PRE-MOUNTING MOSAICS

Photo courtesy of Angie Re of Unique Mosaics, South Salt Lake, Utah

Chapter 6
Pre-mounting mosaics

Pre-mounting Mosaics
General Overview

Pre-mounting tile mosaics can provide many benefits to the installation process. Pre-mounting creates a semi-rigid panel by consolidating multiple pieces into one that can be installed like any other piece of tile. The pre-mounting process also allows for management of tile thickness and variances to achieve a smooth, flat surface minimizing lippage. Further, the materials used for pre-mounting mosaics add crack-isolation properties to the installation. Obtaining consistent grout lines may be facilitated with pre-mounting methods. It is important to use materials that are approved for the specific installation.

If the above methods are practiced, the result will be a faster and easier installation of tile mosaics.

It is important to note that these methods are also applicable to factory-made mosaics. Pre-mounting mosaic borders, for instance, will result in a more precise installation with less mess, less effort to clean joints, a flatter surface, and easier material management. This is particularly helpful when mosaic borders are thinner than the field tile.

Pre-mounting mosaics methods

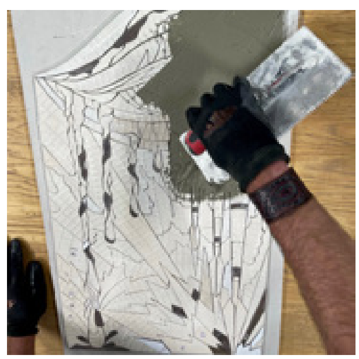
METHOD 1: FABRIC SHEET MEMBRANES
Recommended for materials closer in thickness to the field

1. Lay out clean, dry tile pieces like they are going to be installed and use a mosaic mounting tape on the face of the tiles to secure them in place.
2. If a mosaic is larger than 3' x 3', cut the mosaic into manageable, divided sections that can be labeled and flipped over.
3. Cut the fabric membrane (ANSI A118.10) into pieces, larger than the individual sections to be mounted.

4. Scratch coat the fabric membrane with a lightweight, polymer-fortified thin-set mortar approved for use with the intended specific tile materials (glass, ceramic, porcelain, stone meeting ANSI A118.15, A118.4, A118.11).

5. Use a v-notch to trowel the alkali-resistant fabric (trowel size can vary based on desired thickness).

6. Flat back-trowel the mosaic piece with thinset mortar to ensure a flat plane and compensate for any differences in material thicknesses.

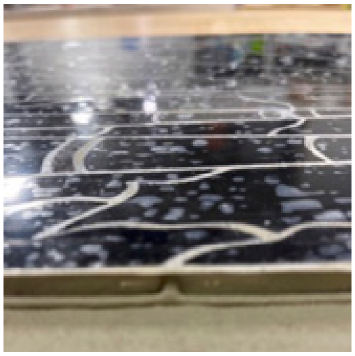


7. Lay your mosaic section on the fabric membrane and using a large, flat, and rigid tool (large enough to cover the tile), such as a beating block or a large-format tile, apply steady pressure on the mosaic piece to achieve a proper bond (can also be accomplished with a vibration tool).

Inspect the joints at the side of the mosaic panel. When a proper bond is achieved, thinset mortar will be visible in the joint at a nominal 1/3 thickness of tile.

Photo courtesy of
Dragonfly Tile & Stone Works

Pre-mounting mosaics methods (continued)



8. With a level, check your piece for flatness. If more compression is necessary, replace the compression block previously used and use a compression tile tool. Clean excess mortar from perimeter of mosaic panel.

9. Allow to cure for appropriate period based on adhesive mortar used (24-48 hours). Remove the face tape and clean any thinset mortar from the joints. Trim excess membrane from perimeter of mosaic panel.

10. Clean tile surface and apply new mosaic face tape (face tape shall be removed after installation and prior to grouting).

- ***It is recommended to produce a mock-up to ensure a proper mortar bond***
- ***If glass tile is used, validate proper bond (ANSI A137.2) per manufacturer specifications***
- ***After installation, create soft joint at perimeter of mosaic inlay as instructed by membrane manufacturer (ANSI A108.17) or, in the case of glass tile mosaics, refer to ANSI A108.16***

METHOD 2: MESH WITH LIQUID WATERPROOFING MEMBRANE

Recommended for varying thicknesses of materials used in mosaic

1. Apply a suitable primer, approved by the liquid membrane manufacturer, to the backs of clean and dry tiles and allow to dry per manufacturer instructions.

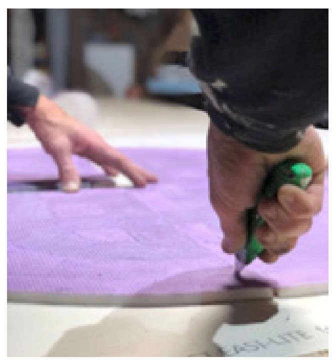
2. Lay out the pieces as they will be installed and place mosaic mounting tape over face of tile.

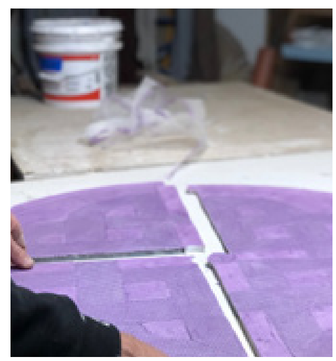
3. Cut into manageable sections that can be labeled and flipped over.

4. Lay an alkali-resistant fiberglass mesh over the backs of the tiles.

5. Apply an even coat of an ANSI A118.10 liquid waterproofing membrane with a brush (taking care not to allow excess in grout joints) and let dry.

Apply a second coat and let dry completely per manufacturer specifications, usually 24 hours.





6. Cut through mesh into manageable pieces

7. Trim excess liquid waterproofing membrane and fiberglass mesh from tile edges.

8. Flip sections over, remove mosaic mounting tape, clean grout joints, and reapply mosaic face tape.

- ***It is recommended to produce a mock-up to ensure a proper mortar bond***
- ***If glass tile is used, validate proper bond (ANSI A137.2) per manufacturer specifications***
- ***After installation, create soft joint at perimeter of mosaic inlay as instructed by membrane manufacturer (ANSI A108.17) or, in the case of glass tile mosaics, refer to ANSI A108.16***

METHOD 3: FOAM OR CEMENTITIOUS BACKER BOARD

Recommended when additional thickness is required for installation

1. Cut foam or cementitious backer board to actual size of mosaic inlay (mosaic not to exceed size of backer board).

2. Place board onto a flat, horizontal surface, such as a worktable, and skim-coat board with thin set mortar (allow to cure per manufacturer instructions).

3. Sand down rough or high spots, trowel thinset mortar over backer board, then install mosaics. Clean perimeter of excess mortar.

4. Refer to ANSI Installation Specifications A108.14, A108.15, A108.16 for installation of mosaics onto backer board.

5. Clean joints. Allow 48 hours for thinset mortar to cure before handling. Grout if desired.

6. After the inlay has fully cured, if needed, cover the face with a mosaic mounting tape for additional protection during transportation and final installation of inlay.

Note: Before moving inlay, slide a piece of plywood or comparable material underneath inlay using straps and/or appropriate packing measures around all sides to stabilize inlay during transportation to jobsite

- ***It is recommended to produce a mock-up to ensure a proper mortar bond***
- ***If glass tile is used, validate proper bond (ANSI A137.2) per manufacturer specifications***
- ***After installation, create soft joint at perimeter of mosaic inlay as instructed by membrane manufacturer (ANSI A108.17) or, in the case of glass tile mosaics, refer to ANSI A108.16***

NOTES:
Transportation procedures for all tile mosaics will depend on size of panel. Sink savers, clamps, rolling carts with attachment straps, and many other tools are available to stabilize the panel. In some cases, an A-Frame may be required.

Pre-mounted mosaic tiles should not be used in submerged or exterior freeze/thaw applications unless recommended by manufacturers of products used.

Advantages of Pre-mounted Mosaic Tile Methods

	Mesh Backing/ Liquid Waterproofing	Fabric Backing	Foam/ Cement Board
Minimizes thickness added to the finished mosaic work	x	x	
Offers excellent adhesion to the setting materials	x	x	x
Creates a rigid tile panel for installation	x (if face taped)	x	x
Reduces the risk of misplacing or breaking pieces	x	x	x
Allows for even and consistent grout lines	x	x	x
Eliminates thinset ooze between tiles when setting	x	x	x
Eliminates height variance issues between pieces of different thicknesses	x	x	x
Eliminates an uneven or wavy tile installation	x	x	x
Minimizes thickness added to finished work	x	x	
Offers crack isolation	x	x	x
Chemically formulated to achieve a proper bond with a modified thinset mortar	x		
Allows for easier vertical stacking during installation	x	x	x
Easier storage and transport	x	x	x
Faster and easier installation	x	x	x

Photo courtesy of the NTCA and LATICRETE co-sponsored Artisan Revolution in Training (A.R.T.) event.

Photo courtesy of National Tile Contractors Association Regional Training Program

7

SPECIALIZED INSTALLATION PROCEDURES

Photo courtesy of National Tile Contractors Association Regional Training Program

Chapter 7
Specialized Installation Procedures

Cold Weather Tiling

GENERAL

The professional installation of tile in cold weather presents a number of problems. The best results will be obtained when the environment and the products are about room temperature. Each bonding material will require specific precautions.

Tile bonding and grouting materials must not be applied to surfaces that contain frost. Tile must not be installed in areas where the substrate is not maintained above 50°F (10 C) or where the substrate is above 100°F (38 C). Temperature of the substrate shall be 60°F (16 C) and rising for application of epoxy and furan unless otherwise specifically authorized by its manufacturer. Maintain epoxy and furan at a stable temperature between 60°F (16 C) and 90°F (32 C) during the curing period.

Industry specifications do not recommend setting tile below 50°F. If work below that temperature is unavoidable, common sense procedures and precautions should be observed. Be aware that it is the temperature of the tile products, bonding materials and substrate that count – not just the air temperature of the room.

COLD WEATHER SLOWS CEMENT HYDRATION (CURING)

It is recognized that cold weather slows the strengthening of cement mortars and grouts and allowances must be made for the resulting risks.

As the temperature drops from 50°F to 35°F, the strengthening of cement slows concurrently, until at 35°F it almost ceases. When these conditions occur, additional time must be allowed for the cement bonding materials to sufficiently harden before traffic is allowed.

If the water in fresh cement is allowed to freeze solid, particularly near the surface, the small ice crystals expand, separating the sand and cement. This destroys the strength of the mortar, resulting in a bond failure.

In cold temperatures, grouting done before the bonding material is strong enough to accept traffic will cause movement of the tile, resulting in irreparable bond failure. When the temperature is below 50°F, grouting should be done immediately after the tile is set or wait at least two to three days. No traffic should be allowed during this period. When continuing a job, special precautions must be taken to keep all traffic off the tile that was set the previous day.

When using blower heaters to protect tile from freezing, caution must be taken to avoid rapidly drying out the tiled area directly in front of the heaters. There is a risk of drying out the air in heated areas, preventing proper curing of mortar and grout. It is advisable to damp cure under these conditions.

The use of electric heat is preferable to oil or gas-fired temporary heaters that can cause chalking carbonation and weakening of fresh mortar or grout.

Cover ungrouted surfaces during the initial setting period for protection against drafts and freezing temperatures.

Fast-setting mortars, although susceptible to freeze damage, may reduce curing time if the manufacturer's recommendations are followed.

EPOXIES AND URETHANES

Epoxies require special cold weather precautions. The most likely conditions to occur because of cold temperatures are:

1. A thick stiff mix.
2. Difficult application.
3. A very slow cure and strength gain.

For these reasons, most epoxy products are recommended for use between 70°F and 80°F. Low temperatures can cause epoxies to become so stiff they are unworkable and curing time is extended beyond practical limits. Epoxies should be stored at room temperatures at least 48 hours before mixing. Most epoxy problems result from improper and insufficient mixing.

Critical Lighting Effects on Tile Installations

GENERAL: This section is to make the tile contractor aware of adverse conditions on jobs that can be affected by significant amounts of natural light and/or those that use wall wash, graze or similar type lighting.

CAUSES

- When natural or artificial light shines on walls and floors at an angle almost parallel to tile surfaces, normal and acceptable inconsistencies in the tile work are highlighted by shadows that exaggerate these conditions and can magnify the effect of natural variation in materials.
- Use of wall wash, graze or cove type lighting, where the lights are located either at the wall/ceiling interface or mounted directly on the wall, may produce shadows and undesirable effects with ceramic tiles.
- Small die release lines inherent on the edges of some ceramic and mosaic tiles, rarely noticeable when installed under normal lighting conditions, can produce large shadows from wall wash lighting.
- Direct bond installations over walls that have not been properly prepared can increase shadowing effects.
- Fixture walls can be accentuated by wall wash lighting due to installations/preparations by other trades.
- Surface trim/accent features not matching wall tile unit create misaligned grout joints and thickness of tile that produce irregular shadows.
- Scored/cut tile grout line will produce different shadows on the factory joint and the installed joint, amplified by critical lighting
- Allowable/excessive lippage and warpage can be accentuated by critical lighting.

NOTE: Lippage is a condition where one edge of a tile is higher than an edge of an adjacent tile, giving the finished surface a lipped or uneven appearance. This condition is inherent in all installation methods and may also be unavoidable due in part to the way tile is manufactured. Please consult ANSI A137.1 for more information.

CORRECTIONS

- Substrate should comply with the flatness requirements in ANSI A108.02 (specifically A108.02.4.1, A108.02.4.1.4.3.1 and A108.02.4.1.4.3.2). It should be noticed that the effect from irregularities in the substrate increase as the tile size increases. As a result, substrate requirements become more important as tile size increases.
- It is recommended that the designer make provisions for evaluating substrate flatness just before installation of the tile.
- Project specifications should make clear which trade is responsible for the required alterations if the subfloor is found not to be in compliance with the flatness requirements.
- Alternately the designer may choose to incorporate a mortar bed method or pourable underlayment to ensure substrate flatness sufficient to facilitate a flat tile installation.
- Lippage is most significantly influenced by substrate flatness and the tile's facial dimension irregularities. The information contained in the "Lippage guidelines, explanation and caution" section of ANSI A108.02.4.3.7 should be heeded and used to explain how the tile installation will be effected.
- Specifying wider grout joints allows for more gradual changes to minimize lippage due to facial dimension irregularities of the tile used.
- To minimize lippage due to tile's facial dimension irregularities , specify tile that meets the dimensional requirements for rectified tile according to ANSI A137.1 and use a larger grout joint.
- Some patterns, such as 50% offset (1/2 offset or brick-joint) pattern, accentuate the effects of warpage and result in more lippage.
- Designers should consult with the tile manufacturer to discuss grout joint size and pattern selections that will minimize issues relating to flatness and lippage (25% [1/4] or 33% [1/3] offset patterns).
- Cushioned or beveled edge tiles can minimize the effects of lippage.

Critical Lighting Effects on Tile

TIPS FOR THE TILE CONTRACTOR

1. Determine in advance, if possible, if the tile installation will be affected by these types of lighting. It may be helpful to visit the site of the intended installation, or to view the electrical, reflected ceiling and elevation drawings of the plans to determine the intended placement of the lighting in the areas to receive tile.
2. As soon as you recognize the potential problem or at the time of the contract award, inform the general contractor, architect and/or owner, in writing, of the anticipated problem by providing a copy of "Critical Lighting Effects on Tile Installations" (page 147). Also provide the lighting placement photos in this section and highlighted areas of the plans showing where the potential problems will occur.
3. Instruct the contractor and other trades that strict adherence to ANSI and/or *TCNA Handbook* preparation and tolerance requirements for walls or slabs is required.
4. Have the permanent light installed before the tile installation, or place your temporary lights directly above the tile installation.
5. Take time to review tile layout, joint size as defined and product in ANSI A108.02.4.3 for dimensional size variation, thickness variation and warpage as defined by ANSI A137.1 to evaluate whether any of these issues will result in a finished installation outside of the design expectations.
6. Instruct the tile installers regarding the potential problems presented by critical lighting and inspect the work at the outset of the installation to verify it is in compliance with the design criteria.
7. Mosaic tile requires special attention to detail during installation. Review tile layout, joint size and product. Minimum 1/8" grout joint size. Refer to ANSI A108.02.4.3.
8. Inspect the subsurface thoroughly prior to installation and require the responsible party to prepare the surface according to ANSI standards. Don't accept the general contractor's or other trades' problems.
9. Use Trowel and Error method of embedding tile to ensure proper coverage and installation. Follow procedure for bonding large-format tile for coverage and support.
10. After permanent lighting or temporary lighting that mimics the planned lighting scheme is in place, have the architect inspect a finished sample area and secure written approval before proceeding.
11. Secure written approval of intended course of action to be taken prior to proceeding the installation.
12. Send a copy of the new installation inspection document (insert title here) to the appropriate parties.

SAMPLE LETTER FOR THE TILE CONTRACTOR

Date

Company
Address
City, State Zip

RE: Project Name
Critical Lighting

Contact:

INTERIOR WALLS AND FLOORS:
Use of wall-washer and cove-type lighting, where the lights are located either at the wall/ceiling interface or mounted directly to the wall, are popular techniques of producing dramatic room lighting effects. When proper backing surfaces, installation materials, methods, and location of light fixtures are not carefully coordinated, these lighting techniques may produce shadows and undesirable effects with ceramic tiles. Similar shadows are created from side lighting interior walls and floors when light shines at that angle through windows and doors.

EXTERIOR:
When natural or artificial light shines on exterior walls and floors at an angle almost parallel close to tile surfaces, normal and acceptable inconsistencies in the tile work are highlighted by shadows that exaggerate these conditions.

Additional pertinent information is enclosed for your perusal. You are encouraged to pay close attention to the potential causes of critical lighting problems. Your compliance with preventive measures will ensure the best opportunities for completion of a performing and aesthetically pleasing installation.

Name and Title
Company

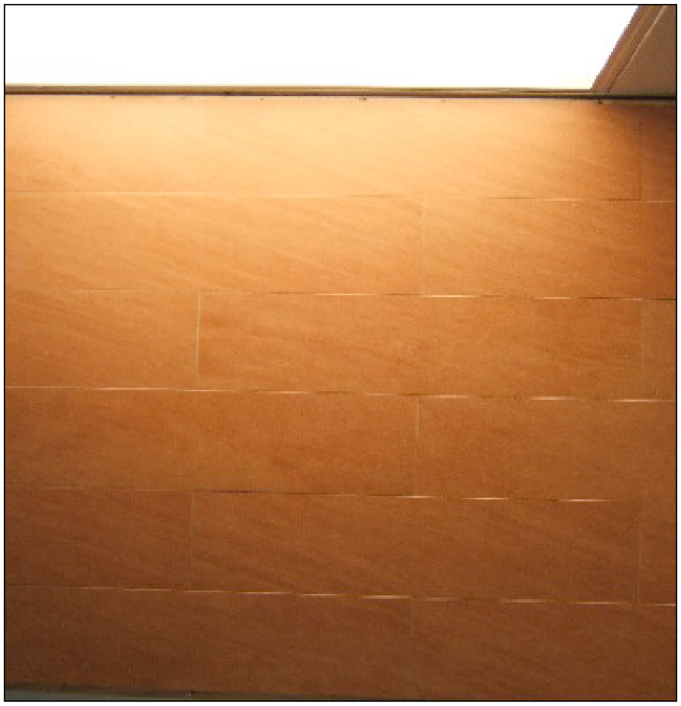
Encl:
NTCA Reference Manual
TCNA Handbook
ANSI A108.2 – ANSI A137.1

This page is for the Tile Contractor's use only!

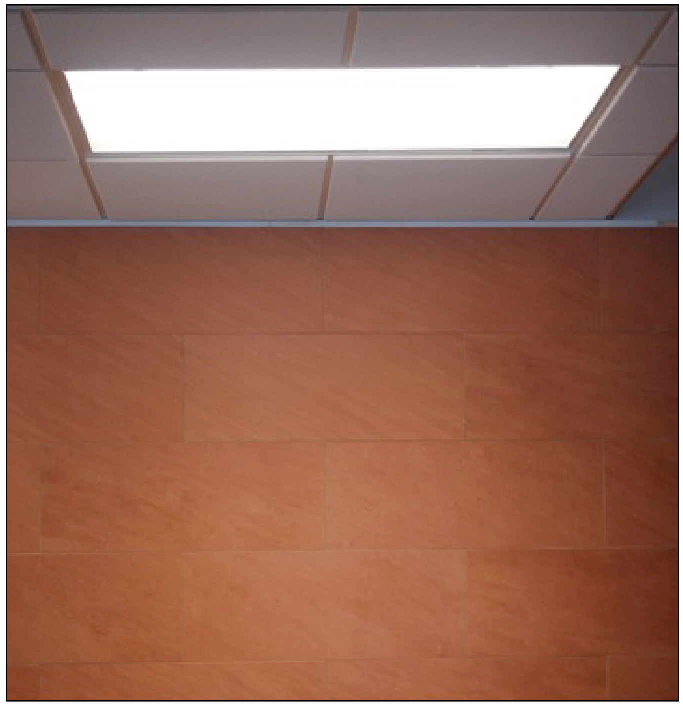
Photo courtesy of Sika Tile

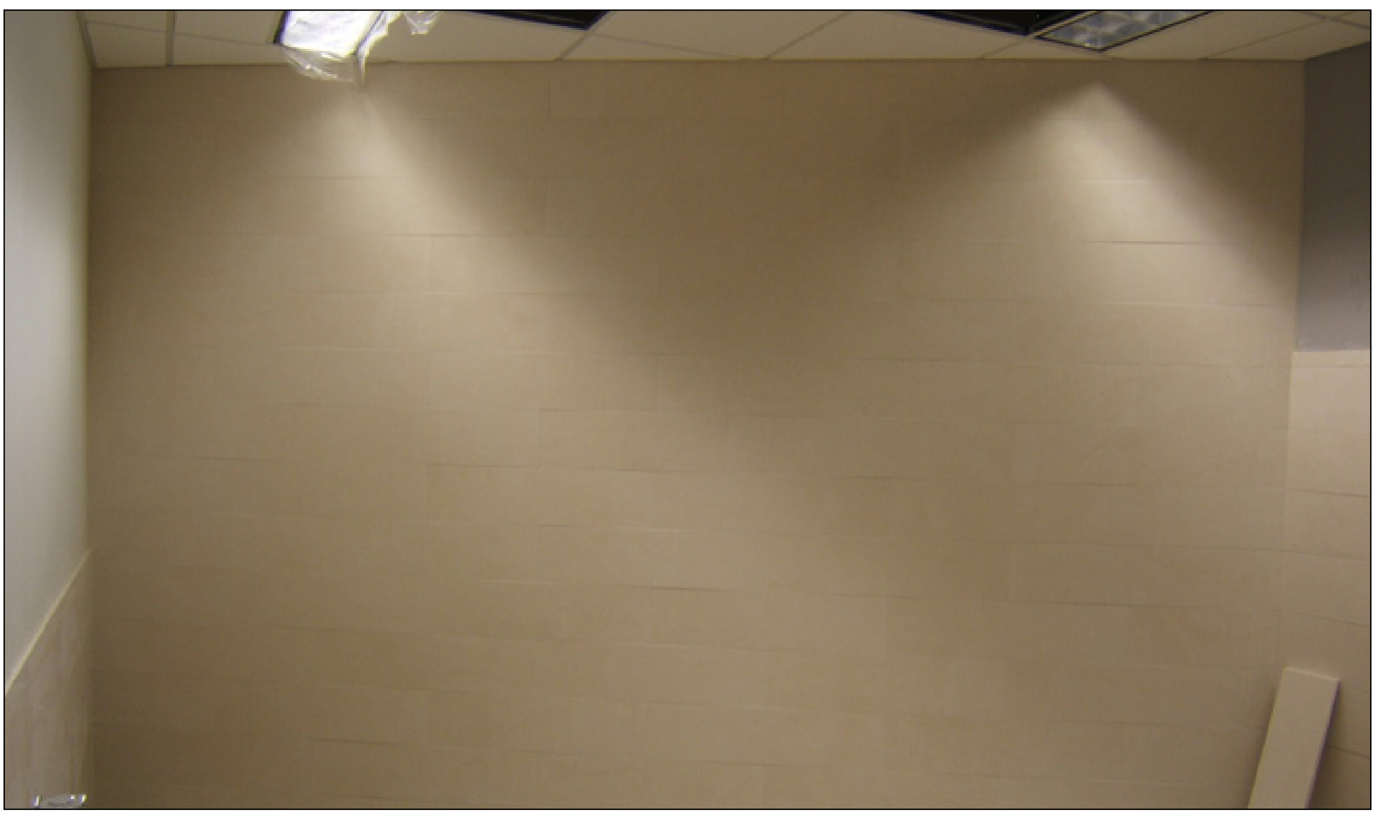
Critical Lighting
Interior Wall Wash

LIGHT AGAINST WALL



LIGHT 24 INCHES FROM WALL





Position of overhead lighting can affect perception of tile lippage.

Lighting Placement

Provided by daltile®

Glazed Wall Tile

Unglazed Wall Tile

The photographs above illustrate the dramatic difference the placement of overhead lighting can make in the appearance of a tiled wall. The photographs on the left show the effect of overhead lighting panels mounted next to the wall resulting in "wall wash". This harsh lighting technique creates harsh shadows that accentuate any irregularities in the tiled surface.

The photographs on the right show the dramatic visual improvement achieved simply by moving the overhead lighting just one ceiling panel (24") away from the wall. The tiled wall illustrates a standard thin-set installation. The wall, fluorescent fixtures and camera angle are exactly the same in both sets of photographs. Only the placement of the lighting fixtures was changed.

Provided by

daltile®

lighting placement

PROBLEMS

• Any type of lighting located on or near tile walls accentuates irregularities by casting shadows on the tile surface joints.

• The appearance of a tile installation is especially affected by critical lighting due to the small individual units, such as 2”x2” tile sizes, and the practical tolerances allowed in the manufacturing and installation of tile.

• Critical lighting problems occur when the tile wall is bathed in vertical light from the ceiling directly over the wall.

• Critical lighting problems also occur when outside natural light, through windows and doors, casts shadows from slightly irregular tile surfaces.

• Small die release lines inherent on the edges of some ceramic mosaic tiles, rarely noticeable when installed under normal lighting conditions, can produce large shadows from wash-wall lighting.

• Four and one-quarter inch tile with factory scored grout lines will produce different shadows on the factory scored joint and the installed joint, amplifying the individual 4-1/4” unit.

• Thin-set mortar installations over masonry walls with critical lighting produce an almost impossible condition for shadow free walls.

PREVENTIONS

• Locate light fixtures at least 24 inches away from the wall; preferably in the center of the room.

• Avoid the use of ceramic mosaics and scored tile where wall lighting is necessary.

• Requiring smooth, flat wall or floor surfaces within ANSI standards’ tolerances will reduce the shadows.

• Installing the permanent lights prior to the tile installation will allow the tile installer to make some adjustments during the installation.

• Changing the thin-bed installation to a mortar bed installation with the tile installed while the bed is soft will reduce installation shadows, but will not eliminate the shadows produced by the irregularities in the manufactured tile.

Tips For The Contractor

• Inform the architect and/or owner of the anticipated results by providing a copy of this brochure.

• Recommend that the lighting be moved at least 24 inches from the wall; and preferably to the center of the room.

• Instruct the contractor and other trades that the strict adherence to ANSI and TCNA preparation and tolerance requirements for walls or slabs be strictly adhered to and provide a copy of the requirements.

• Have the permanent lights installed before the tile installation, or place your temporary lights directly above the tile installation.

• Use tile from manufacturers who meet high standards of mounting, uniform thickness and warpage control.

• Avoid the use of ceramic mosaics and scored tile on critical lighting walls or floors.

• Where wall-wash lighting effects are desired, inspect the subsurface thoroughly prior to installation and require the responsible party to prepare the surface according to ANSI standards. Use Methods W201, W211, W221, or W222 when installing tiles over concrete block masonry; and use Methods W231 or W241 when installing tiles over stud walls to produce the flattest surfaces. For best results, mortar beds should still be plastic during installation of tiles. Don’t buy the contractor’s or other trades’ problems.

• Give proper orientation to the tile installers; emphasize the high-risk aspect of the installation; and make an early inspection of the installation using light directly against the tile.

• Use large beating block and properly “beat-in” tile.

• On multi-room jobs, have the architect inspect the first tiled and grouted wall.

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Light Strategy Emphasis for Tiled Wall Surfaces

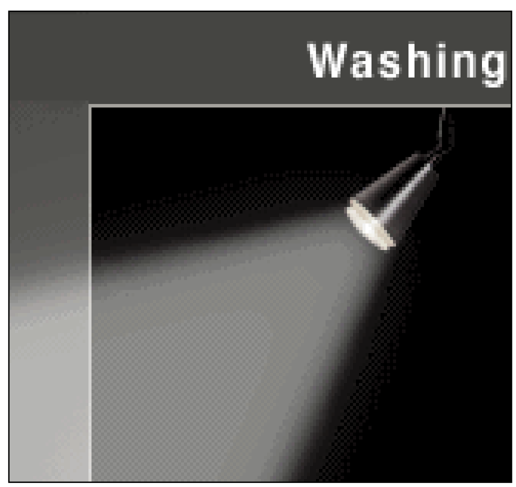
Grazing/horizon lighting and wall wash lighting are common techniques that create the opposite effect. On tiled walls changing the way light impacts them can produce dramatically different results.

Consider a brick, ledger stone or tiled wall with a rough finish where emphasis is on texture and shadow. Graze the surface with light, meaning the light would strike the surface at a sharp angle. In this case, the light source would be mounted to the wall or very close to the "horizon" of tiled wall and ceiling.

RESULT: Varying texture, shadows and depth of the tile and grout joints are maximized.

Now consider the wall has a painted or tiled surface with a very flat finish, where the emphasis is uniformity and smoothness. Wash the surface with light, meaning the light would strike the surface at a wide downward angle. In this case, the light source would be mounted 18" to 24" out from the tile wall.

RESULT: Tone, color and the smooth bright finish of the tiled wall is maximized while providing a flatter, more uniform appearance to the grout joints.



Grazing or Horizon Lighting Maximizes Shadow and Texture, Often With a Negative Effect

Baffling the light can help.

Light box, upward light, reflective ceiling can provide a softer more uniform profile to the tiled wall.

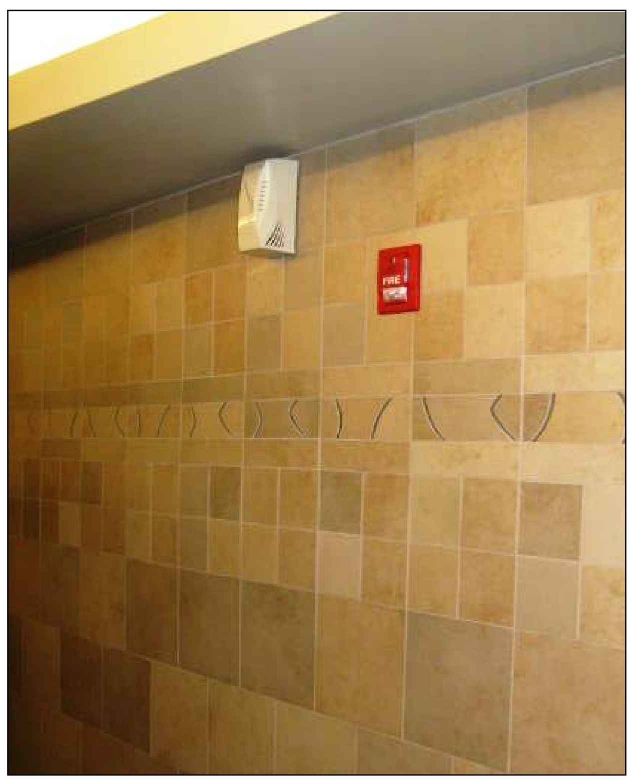


Photo courtesy of Artistic Tile

Hot Weather Tiling

Tile installed under conditions of high temperature, low humidity or wind, singly or in combination, present unique challenges to our industry. Yet, an understanding of the effects that each of these environmental influences exerts on setting mortars, grouting materials and organic adhesives and observing recommended practices intended to minimize their effects can yield satisfactory installations under these adverse conditions.

Hot weather is defined as any combination of high air temperature, low relative humidity and wind velocity that affect the performance of setting and grouting materials. Undesirable hot weather effects on Portland cement mortars and grouts include increased mixing water or latex demand, increased loss of workability, the tendency to re-temper the mix during use, and an increased rate of skinning for mortars. Further, hot weather increases the tendency for dry shrinkage cracking of mortars and grouts, poor physical strength of the cured materials from the use of higher levels of water or latex during mixing, improper curing and ultimately decreases the durability of the installation.

For organic adhesives, hot weather produces a creamier texture, increased workability and a tendency to trowel too large an area before applying tile. Hot weather causes rapid skinning and loss of open time of organic adhesives due to the increased evaporation of water. Again, the durability of the installation is compromised by the potential for poor transfer of the adhesive to the tile back.

Epoxies are profoundly influenced by hot weather conditions. These conditions sometimes reduce the viscosities of epoxies making them more workable. Yet, hot weather always accelerates the rate of cure, which can and has resulted in the loss of many a mixing paddle and marred finished tile work by an extremely difficult to remove epoxy film.

So why, when confronted with all of these negatives of hot weather tiling, would anyone consider proceeding with a ceramic tile installation under these adverse conditions? The answer is simple – economic necessity.

The following recommendations are intended as a guideline to minimize or control the conditions caused by hot weather as noted earlier. Be aware that none of the following recommendations by itself may be sufficient to address problems at a particular installation. Rather, by necessity, each installation will need to be evaluated on an individual basis and the appropriate recommendations employed.

Evaluate exterior installation sites in advance. Will the installation be exposed to direct sunlight all day or for a portion of the day? Will the site be subject to prevailing winds? Can shade be provided by a temporary shelter that can be moved as work progresses, or is it better to work at night? The answers to these questions are critical to your success. Substrates exposed to direct sunlight will be hotter than those in shaded areas. This additional heat will cause a rapid loss of workability of cementitious grouts and mortars, increase a mortar's tendency to skin and cause a cementitious system to dewater prematurely and fail to achieve its design strength. Shading the installation can offer a solution as can adjusting the work schedule to the night or cooler portions of the day. Cooling the substrate with water before beginning the installation may be beneficial. But, care should be taken to remove all excess water before applying the mortar.

MATERIALS

Keep all materials in a shaded area and do not store materials in closed trucks or vans. This includes tiles, mixing liquid, setting and grout materials. If any material is warm to the touch it is suspect. Don't use tile that is hot to the touch. Cool your materials before proceeding. Some manufacturers market products specifically developed for hot weather conditions. They can be consulted concerning their products' performance and recommendations under specific job conditions.

PORTLAND CEMENT MORTARS AND GROUTS

If using water, fill buckets and put them in a shaded area. If possible, use a combination of ice and water. Mixing water has the greatest effect per unit weight of any of the ingredients on the temperature of a cementitious mortar or grout. It has a specific heat* between four or five times that of cement or aggregate. Thus a change in water temperature of about 4°F can effect a 1°F change on a mortar or grout. By using ice water, a more dramatic temperature change can be effected. The use of cold water will result in a decreased water demand of the mortar or grout when mixing. The working time of the mortar or grout will be increased and the workability will be improved. Using warm or hot water will cause an increase in water demand, consequent decrease in performance, a rapid loss of workability and decreased pot life. An analogous situation exists for latex additives. Except here, the addition of ice to the latex admixture is not recommended. A better recommendation would be placing the latex admixture containers into an ice chest filled with crushed ice. The containers can then be removed and the pre-cooled latex used as needed. Before applying dry-set or latex modified Portland cement mortars to concrete substrates, dampen the concrete to cool it down slightly. Control how much mortar is troweled and combed before setting the tile. High temperatures and wind can combine or skin a mortar in several minutes. Check for mortar transfer to the tile backs often as the installation proceeds. Scrape off and discard skinned mortar and apply fresh material whenever skinning is noted. Never re-temper or add additional liquid to a mortar or grout that has lost its workability. Begin damp curing installations involving unmodified cementitious materials as soon as it is practical.

Rapid water loss can result in dry shrinkage cracking that will compromise the integrity of the installation and ruin an otherwise acceptable grout application.

ORGANIC ADHESIVES

The viscosity of organic adhesives decreases with higher temperatures, making it easier to spread and trowel. Avoid the tendency to spread too large an area before tiling. In higher temperatures and in the presence of drafts organic adhesives skin over rapidly, preventing good transfer of adhesive to the tile being installed. Check transfer often by removing a tile and observing the amount of adhesive on the tile back. Cooling the adhesive will help somewhat, but cooling in an ice bath is not recommended since the workability of the adhesive will be adversely affected by the increased viscosity.

EPOXY MORTARS AND GROUTS

Every effort possible should be made to keep the temperature of the epoxy, tile and substrate below 90°F. This may require working at night, the use of ice bath to cool the mixed epoxy and control its rate of setting or the application of damp blankets or towels to the installed tile before grouting in an effort to cool them. Do not over mix the epoxy mortars or grouts. Do not pre-moisten concrete substrates before applying epoxies. All manufacturers of those materials require that the components be intimately mixed for optimum performance. This can be observed as a homogeneous lump free mix or by a thorough wetting of the aggregate or by uniform color. When any of these conditions is observed STOP MIXING! Excessive mixing will accelerate the rate of cure still further from the heat generated by the mixing action. When grouting, do not attempt to grout large areas of the tile field before clean-up. The result can be an extremely difficult to remove cured epoxy film on the tiles.

*__Specific Heat__ - The ratio of the heat capacity of a substance to the heat capacity of water, or the quantity of heat required for a 1 degree temperature change in a unit weight of a material. Commonly expressed in Btu/lb/degree F or in Cal/g/degree F.

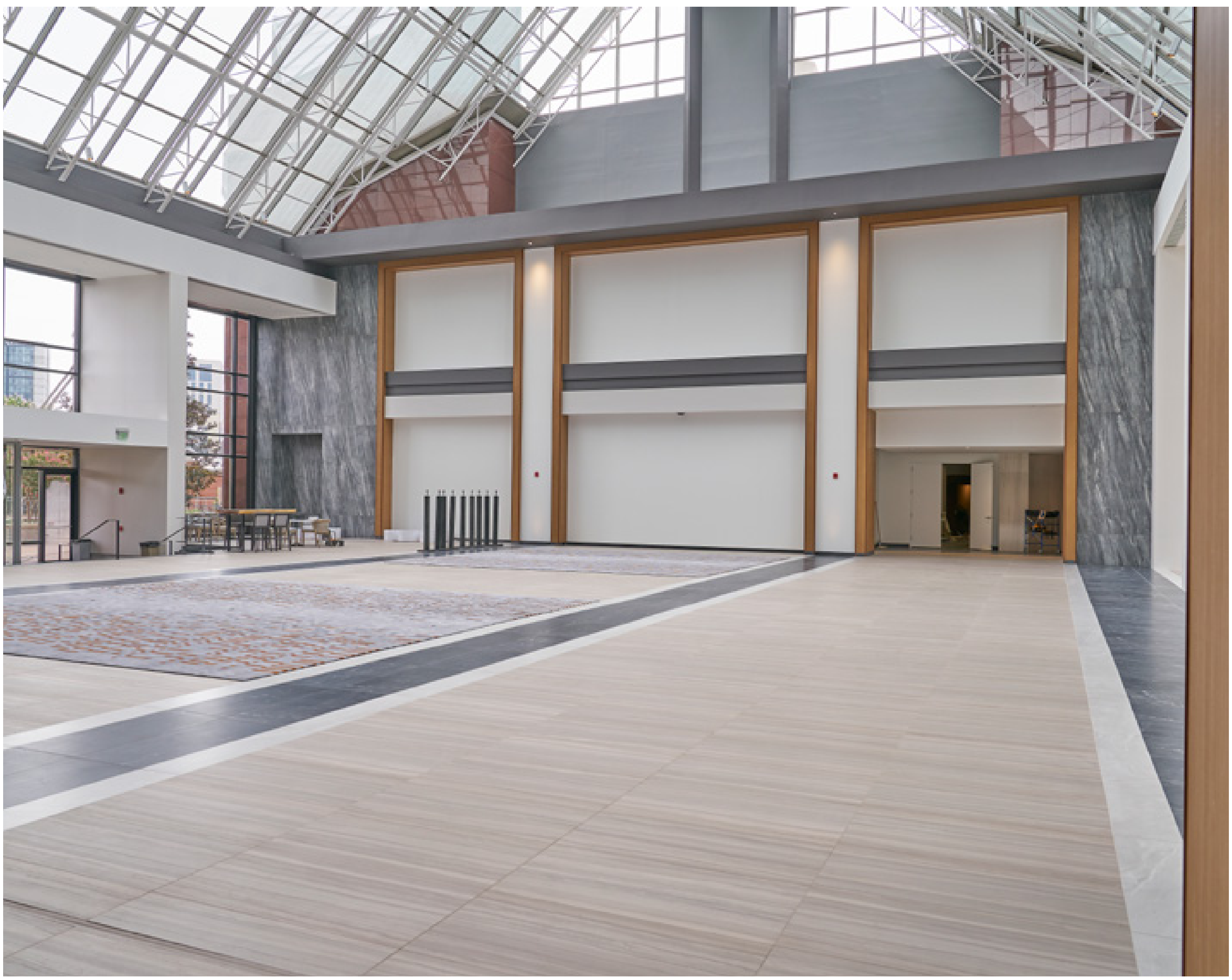


Photo courtesy of Custom Building Products

Large Porcelain and Glass Bodied Tiles

Problem	Cause	Cure
Loss of bond between bond coat and large porcelain tiles or tiles containing high percentage of glass in the body. Tiles may come off mortar bond coat clean, even with full coverage on backs of tiles.	***Any of the following may prevent problems with large porcelain and glass bodied tiles.*** Inadequate contact between mortar bond coat and backs of tiles, which may be caused by improper beat-in and using inadequate amounts of mortar, or worn or improper trowels. Use of pure cement bond coat over plastic mortar beds. Use of dry-set mortar without latex additives. Presence of excessive white powder (manufacturer's release agent) on back of tile. Bending or deflection of substrates. Differential expansion between tile and setting material. Working on or too early traffic on newly laid tile floors. Shrinkage or setting of substrates due to changes of moisture in structure or movements in the structure after construction is complete. Improperly engineered structure for the installation put into place.	***Any of the following may be a cure to problems with large porcelain and glass bodied tiles.*** To secure good contact between tiles and ribs of latex-Portland cement mortar, tiles must be pushed and slid into the mortar using NTCA recommendations for bedding tiles. Flat back-troweling tiles with a thin, flat coat of latex-Portland cement mortar helps develop a better bond to the tile. On large format tile, a box screed has proven to be an excellent means of controlling the amount of mortar applied to the back side of large tiles. Latex-Portland cement mortar applied to the substrate should be troweled out evenly in one direction – not swirled – with notched trowels. Ribbed mortar on only one surface helps reduce voids and air pockets. This method also produces a smoother, more even surface than conventional flat back-troweling, which often leaves tiles with excessive lippage. Successful installations of large porcelain and glass bodied tiles require the use of a manufacturer's recommended latex-Portland cement mortar that meets or exceeds ANSI specifications. Use latex-Portland cement mortars that are more flexible, in addition to having superior bonding capability. Latex-Portland cement mortars bond large porcelain tiles and tiles containing glass in the body, better than more conventional mortars. Mortar flexibility helps bridge stresses created between substrates and large, unforgiving tiles, reducing possibility of tiles shearing off. Check with manufacturer for exact products recommended. Press or slide tiles into position using the Trowel & Error method for bedding tiles (*See page 167*). Check to see that uniform contact is being achieved at corners, edges, and the back of the tiles by pulling tile up

Arizona Tile Themar Statuario V Porcelain

Cure *(contiinued)*

for examination. Beating-in ***only*** of larger tiles generally is not effective. Average contact area shall not be less than 80% except on exterior or wet area installations (see *TCNA Handbook* for wet area definition) where contact area shall be 95% when not less than three tiles or tile assemblies are removed for inspection.

Check tiles for presence of excessive white powder (manufacturer's release agent) on back of tile. If necessary, brush or remove white powder before attempting to bond tile.

Porcelain tiles have extremely low water absorption rates. As a result, the setting time of many latex-Portland cement mortars may be extended. Therefore, working on or exposing the installation to traffic prior to a good bond forming may result in poor performance of the completed job.

Proceed with caution when installing large porcelain tiles over substrates subject to bending or deflection. When installing materials with special or unique properties, the code minimum may not be sufficient to provide satisfactory performance. Each project presents its own conditions; consult with owner or builder to determine if any modifications to the structure can be done prior to the installation when you suspect problems or have concerns.

Web floor trusses and engineered I-Joists are used in ways that weren't possible with traditionally sawn lumber. Be aware of the conditions you face prior to installation so adjustments can be made if necessary. See NTCA's document on *Installations over Engineered Wood Products* in Chapter 2 for additional information.

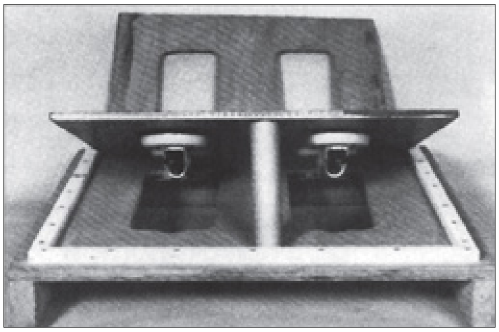
Require architect or construction manager to locate movement joints in tile work as recommended in the *TCNA Handbook.* Design, locations, spacing, and actual installation must conform with requirements in the *TCNA Handbook* and ANSI Standards. Movement joint recommendations apply to residential construction as well as commercial and industrial construction.

When faced with installation of large porcelain tiles or tiles with glass in the body, insist on using latex-modified Portland cement mortars when they are not specified. Also, require mortar manufacturers to furnish test results showing bonding and flexural capabilities of mortars and bondability of tiles from tile manufacturers.

Box Screed

Essentially a box screed is a jig used to apply mortar onto the back side of large-sized ceramic, marble and granite tiles that may vary in thickness or flatness, in order to achieve a uniform unit of thickness of the tile and mortar combined.

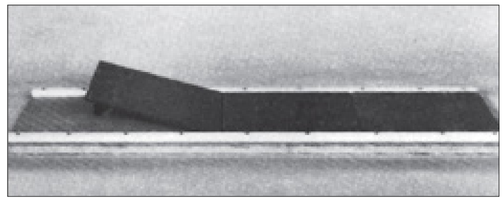
Example #1



The illustrated box screed is made specifically for a 24” x 24” tile. The base is a Georgia Pacific 3/4” pine ply form 27-3/4” square, fastened to two 2 x 4s with #8 x 1-3/4” screws. The screed strips are high density polyethylene, drilled and countersunk and fastened to the base with #8 x 1-1/4” screws. The thickness of the screed strip is determined by the exact thickness of the tile used plus 1/8” of mortar. The 1/4” plywood piece is cut to the exact size of the tile. The base and the 1/4” plywood have corresponding holes cut to accommodate the suction cups shown.

Place the 1/4” plywood on the surface of the tile and affix the suction cups. Remove the 1/4” plywood and place the tile face down into the box screed base. Trowel properly prepared mortar onto the back of the tile and screed off excess with a straight edge. Reach underneath the box screed and lift tile enough to grasp the suction cup handles. Place tile on vertical or horizontal substrate.

Example #2



The illustrated box screed is specifically for a 12” x 12” tile. Materials and method of construction are the same as example #1. Overall dimensions – 16-1/4” x 42”.

Place the tiles into the box screed from one end, pushing them through with no space between tiles. Trowel properly prepared mortar onto the back of the tiles and screed off excess with a straight edge. Remove and install tiles.

GENERAL

Best results are obtained when mortar is keyed into the substrate with the flat side of the trowel; then combed in one direction with the proper notched trowel. You now have a gauged amount of mortar on the tile and on the substrate. Placing the two gauged mortar surfaces together, push tiles into the mortar and move them perpendicular ***across*** the ridges forward and back approximately 1/8” to 1/4” to flatten the ridges and fill the valleys. This technique can produce maximum coverage for large size tiles – with the corners and edges fully supported – without flat back-troweling or beat-in. Periodically remove and check a tile to assure proper coverage is being maintained.

Support the box screed on a solid work surface near the substrate being tiled for faster, easier and more efficient production.

While the illustrated box screeds were made of quality materials for continuous use in NTCA workshop programs, jobsite box screeds can be made from plywood sanded one side for the base and any good hardwood for the screed strips. Construct the box screed to fit the particular size and thickness of the tile being installed, with the length determined by job requirements or individual preference.

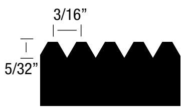
The tiles should fit snugly into the box screed to avoid mortar on the edges. Careful measurement of the thickness of the screed strips is essential for application of the proper amount of mortar. Screed strips can be screwed or nailed to the base. In either case, the screw or nail heads must be below the surface of the screed strips.

Trowel Guidelines

ADHESIVES

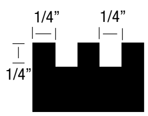
4-1/4” wall tile and ceramic mosaics on dry wall:

3/16” x 5/32”



6” x 6” to 9” x 9” on dry wall:

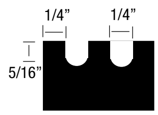
1/4” x 1/4” x 1/4”



DRY-SET MORTARS

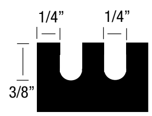
4-1/4” wall tile and ceramic mosaics on masonry and concrete:

1/4” x 1/4” x 5/16”



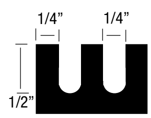
6” x 6” to 9” x 9” on masonry walls or concrete:

1/4” x 1/4” x 3/8”



12” x 12” and larger on masonry walls, concrete and dry wall:

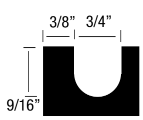
1/4” x 1/4” x 1/2”



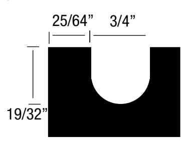
LHT MORTARS

12” x 12” and larger size tiles on masonry or concrete, tiles with thickness variation:

3/8” x 3/4” x 9/16”



25/64” x 3/4” x 19/32”



NOTE: Trowel diagrams not drawn to scale.

PROPER USE OF TROWELS AND OTHER IMPORTANT INFORMATION:

1. Always check trowel for excessive wear before using.

2. Use the flat side of the trowel to key mortar or adhesive into substrate to achieve the best possible mechanical bond.

3. Comb in one direction with the notched side of the trowel, holding it at a 45 degree angle. Specifications require no less than 3/32 inch (2mm) mortar and 1/32 inch (1mm) adhesive between tile and substrate after proper bedding.

4. Set tile with a sliding motion perpendicular to the mortar ridges.

5. The 80-95% coverage shall be sufficiently distributed to give full support to the tile with particular attention to this support under all corners and edges of the tile.

6. Installer must periodically remove sheets or individual tiles to assure proper bond coverage consistent with industry specifications. Lack of adequate coverage may be due to improper bedding of the tile, inconsistent angle of the trowel during application, or use of a worn trowel.

7. Button back, lugged or key-back tiles require special attention. See notes below.

Notes:

1. “Proper Bedding Procedures” is located on page 116.
2. Large and Heavy Tile Mortar (LHT Mortar) information is located on page 114.
3. Dry-set mortars include dry set and latex modified mortars.
4. Box screed, recommended for 12” x 12” and larger tiles, is located on page 160.

IMPORTANT NOTICE:

These guidelines cannot address every installation circumstance. The substrate, type and size of tile, intended service level of the installation, climatic conditions, interior or exterior use, and individual manufacturer’s recommendations are all factors the installer should consider in selecting the proper trowel.

Flat Back-troweling and Notched Back-troweling
(Formerly Backbuttering and Buttering)

The purpose of this document is to provide clarity to the new industry designations for applying adhesive to the backs of tiles and stone, commonly referred to as backbuttering or buttering. The terms backbuttering and buttering have taken on their own definitions in different parts of the country and have been mistakenly associated with spot bonding. When these methods are used properly, they assist with ensuring mortar contact to the tile for proper adhesion. In the case of tiles with recessed patterns or rough profiles, flat back-troweling also assists with achieving required mortar coverage provided troweled ridges on a properly-prepared substrate are completely collapsed.

Flat Back-Troweling is defined as:
"*The application – using the flat side of the trowel (keying in or burning in) – of a thin layer of modified/non-modified dry-set mortar (thin-set mortar) to the backside of ceramic, porcelain, glass and stone tile just before the tile is embedded into the setting mortar.*" (Note: When done correctly, the flat side of the trowel will make a scraping sound on the tile back as pressure is applied to the surface.) This was formerly known as backbuttering.

Notched Back-Troweling is defined as:
"*After flat back-troweling has been completed, additional modified/non-modified dry-set mortar (thin-set mortar) is applied to the backside of ceramic, porcelain, glass and stone tile and uniformly combed in one direction with an appropriate notched trowel just before the tile is embedded into the setting mortar.* (Caution: When notched back-troweling is used, the embedded thickness of the dry-set mortar bed cannot exceed ANSI or manufacturer requirements.) Formerly known as Buttering.

CAUTIONARY NOTES:

• Using dry-set mortar/thin-set mortar to true or level the substrate is not recommended. Additional dry-set mortar/thin-set mortar when applied to the back of a tile is not a substitute for a properly-prepared substrate meeting flatness requirements for the specified tile, whether it be ceramic, porcelain, stone, glass, etc. It is used only to add mortar to fill irregularities of the tile underside and compensate for thickness variations of the tiles and promote increased bond strength.

• Notched back-troweling is not to be confused with the Box Screed Method of installation, which is discussed in Chapter 7: Specialized Installation Procedures in this *Reference Manual*.

• Neither flat back-troweling or notched back-troweling should be construed in any way to allow spot bonding of tiles. When mortar is notched to the tile back, the ridges must be collapsed when placed to create adequate coverage.

FLAT BACK-TROWELING

Flat back-troweling tiles – as stated in ANSI A108.5 – is listed as an option to achieve the desired coverage. Flat back-troweling may help with coverage, but it will not provide the necessary coverage for an installation by itself. The other option listed in the standard to achieve the needed coverage is to "select a notched trowel sized to facilitate the proper coverage." Selecting the properly sized notch trowel to achieve the needed coverage for an installation is a key requirement for any properly installed installation.

Flat back-troweling can, however, promote increased bonding strength of the bond coat material. By spreading the thin layer of bonding material to the back of the tile, the bonding material is now forced into any surface voids of the tile. The tile should be installed and embedded in a properly-prepared notched surface while the mortar is wet, ensuring the wet transfer of the mortar. This increases the bond strength as the flat back-troweling has increased the contact of the bonding coat material to the back of the tile versus a tile that was not flat back-troweled.

Another suggested use of flat back-troweling tiles is to fill voids in the patterned backs of tiles that often occur in the manufacturing process. By filling in the voids, the back plane of the tile is now more uniformly flat, allowing the notched ridges of dry-set mortar/thin-set mortar in a properly-prepared installation surface to fully collapse without any voids or air pockets.

Flat back-troweling tiles can fill in the inherent warpage of tiles; however, one must pay attention to the dry-set mortar/thin-set mortar manufacturer's maximum thickness allowed for the bonding material that is being used. By filling the inherent warpage of a tile, the back plane of the tile is flatter and can be compressed uniformly into the properly-prepared notched ridges of the installation surface allowing ridges in the dry-set mortar/thin-set mortar to fully collapse without voids or air pockets, providing the mortar coverage and support required per ANSI A108.5.

Flat back-troweling is also recommended when installing stone or large-format tiles.

NOTCHED BACK-TROWELING

Notched back-troweling is required for the installation of GPTP (Gauged Porcelain Tile Panels) per ANSI A108.19.13.6. Because the motion to slide a tile to collapse the ridges is virtually impossible with GPTP, notched back-troweling is the technique used to fill the ridges between the substrate and the tile when it is installed. ANSI A108.19.15.0 contains the required mortar coverage requirements specific to GPTP.

There are a few instances in installation procedures, such as installing tile on a ceiling, installing irregular or cleft stone tile or installing handmade tiles that are naturally warped, where it may be advantageous to key the mortar into the substrate and use notch back-troweling to apply mortar to the back of the tile before placing the tile on the substrate and embedding the tile. As always, the notches must be in one direction, aligned (parallel) with the substrate notches creating a zipper effect and fully collapsed to achieve the necessary mortar coverage and support.

CAUTIONARY NOTE: Any time notched back-troweling is used, the embedded thickness of the mortar cannot exceed the dry-set/thin-set mortar manufacturer's requirements or that of ANSI. As always, selecting the correct size of notch trowel for mortar application is a key requirement for any properly installed installation.

Mark Heinlein, NTCA Technical Director, demonstrating flat back-troweling.

Photo courtesy of APE Grupo

Flat Back-troweling & Notched Back-troweling

SUMMARY
Flat back-troweling and notched back-troweling are not required for most installations, refer to ANSI or *TCNA Handbook* methods as to when either one of these techniques is recommended or required.

Certain references in industry specifications and manufacturers' literature may leave the specifier and installer unsure about the necessity or requirement for flat back-troweling and notched back-troweling. If the thin bond coat on the back of the tile that is considered flat back-troweling is not embedded thoroughly enough to contact and collapse the notched ridges of a properly-prepared installation surface, it serves no purpose except to increase the cost of the installation through extra material and labor costs.

As with all installations, the bond coat coverage required depends on the type of installation. Per ANSI A108.5 interior or non-wet area installations require 80% coverage, while exterior, wet area and stone installations require 95% coverage. Flat back-troweling a tile cannot take the place of the coverage requirement. It may look like you have 100% coverage when you flat back-trowel a tile, however, coverage also requires for the tile to be fully supported as specified under A108.5. Notched back-troweling can help with the coverage requirement and support of a tile, but once again a properly-prepared installation surface with the proper sized notch trowel will ensure the coverage and full support as required by ANSI and the *TCNA Handbook*.

It is the position of the NTCA Technical Committee that installing tile using the one directional troweling method and collapsing the ridges through a sliding motion perpendicular to the troweled ridges is the best method for properly installing tile. There are specific uses for flat back-troweling and notched back-troweling. If these specific uses are not done properly, there is little to no benefit to the tile installation, only causing increases in time and cost.

Mark Heinlein, NTCA Technical Director, demonstrating flat back-troweling.

Photo courtesy of NTCA Member
Michael's Custom Tile

Use of Fast-Setting Mortars to Reduce "Down Time" in Freezers or Coolers

Step 1: Empty and shut down the freezer. Rent a freezer/cooler truck if necessary for storage of the contents.

Step 2: Prepare the substrate. All of the standard ANSI and *TCNA Handbook* guidelines for ceramic tile installations must be met, and the substrate temperature must be brought up to 70 to 80°F prior to tiling.

Note: Frequently this step may require considerable time and effort, since substrates may be coated with grease or old partially bonded flooring materials. The time required for Step 2 will be the same, regardless of whether rapid setting materials will ultimately be used to set the tile.

Step 3: Setting Tile. The use of a fast-setting mortar may reduce the cure time needed prior to restarting the freezer/cooler. Check with the mortar manufacturer for their recommended curing times, prior to grouting, and prior to exposure to freezing conditions. Be sure to follow their instructions for mixing, admixes, application, and proper embedding of tile.

Step 4: Grouting. Typically, a cure time of 4 hours must be allowed after the last tile has been set, prior to grouting. Check with the grout manufacturer for their recommended curing time prior to exposure to freezing/cold conditions, and be sure to follow their instruction for mixing, admixes, application, and clean-up. Excess water will need to evaporate prior to restarting the freezer/cooler, so use as little water as possible in clean-up. Use a wet vacuum or Turkish towels to remove as much water as possible after the final cleaning.

Step 5: Curing. Both the mortar and grout manufacturers are likely to recommend a minimum of 24 hours (or longer) cure for their products prior to restarting the freezer/cooler. This requirement ***must*** be observed; use the longer of the two time requirements if they differ. At this stage it is important to obtain the best possible curing of the installation, while minimizing the amount of free (excess) water.

Note: This curing step is where fast-setting products save "down" time. Traditional thinset installations may require up to a month of "room temperature" curing prior to exposure to freezing conditions. Because of their rapid setting nature, fast-setting products may achieve similar strengths in 24 to 48 hours. This is important because once the installation is "frozen" there will be no significant increase in its strength.

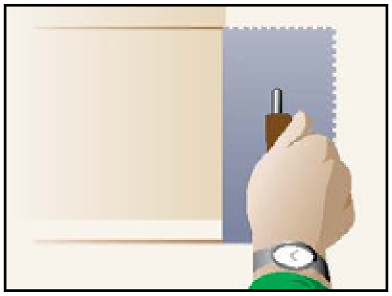
Disclaimer: It is best to rent a freezer truck and shut down the installation in question for as long as necessary (ideally 28 days plus substrate preparation time) to allow the cement to fully cure. Specialized products are available that don't contain Portland cement, cure at low temperatures, or cure almost completely within 1–2 days. However, these materials tend to be expensive, and require special procedures that are unfamiliar to many tile installers.

Regardless of the rapid setting nature of the products discussed, freezing before a full 28 day cure is an abuse of any Portland cement based material. Performance will be less than optimum, so "High Performance" products are required in order to obtain barely adequate results. All recommended admixes should be used at full strength, according to the manufacturers' instructions. Some deterioration of the grout and setting material may still occur over time, particularly if the installation is exposed to heavy traffic or repeated wet/freeze/thaw cycling.

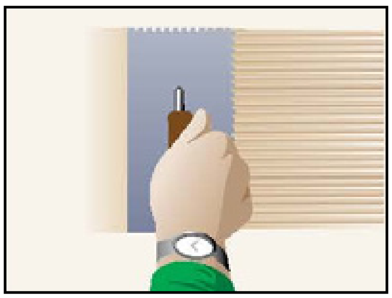
Bonding Large-Size Tile For Coverage, Support and Reduced Lippage

<u>**The procedure is:**</u>

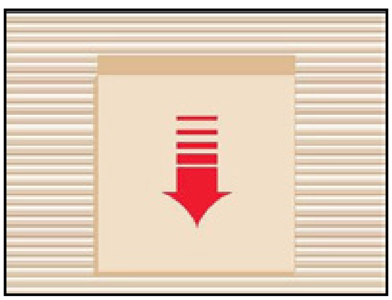
1. Key mortar into suitable substrate to receive ceramic tile or stone with the flat side of the trowel.



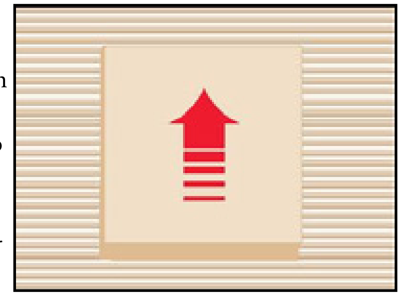
2. Comb – **in one direction** – with notched side of properly selected trowel.



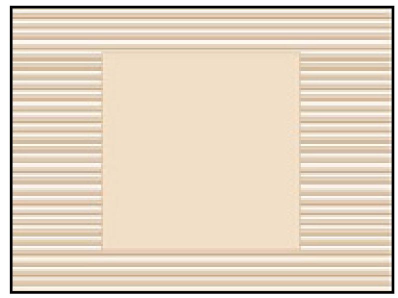
3. Firmly press tiles into mortar and move perpendicular **across** the ridges approximately 1/8" to 1/4".



4. Pressing firmly move back in the opposite direction 1/8" to 1/4" to flatten ridges into the valleys, removing air from between the mortar and tiles



5. This method can produce specified coverage with the corners and edges fully supported, without flat back-troweling or beat-in.



6. Periodically remove and check a tile to assure proper coverage is being attained.

(photos not to scale)

Proper Troweling Method can be found online at http://bit.ly/NTCATrowelandError

NOTE: This procedure is not intended to overcome improper trowel selection or substrate preparation required by ANSI Specifications. Refer to the *TCNA Handbook's* "Substrate Requirements" section for more information on Substrate Tolerances, Mortar Coverage, Flatness and Lippage information.

Tiles 8" square or larger present special challenges and require new procedures to produce professional and aesthetically acceptable installations. Rectangular and square tiles up to 16" and 24" have become quite common. Even tiles up to 36" are available to the tile trade, not to mention larger marble and stone tiles.

Emphasis must be placed on the necessity of other trades providing a flat and even surface for the professional installation of these large size products.

New installation techniques are required to aid in reducing installation time and ensure specified coverage of dry-set mortar over the entire bonding surface of the larger tiles, including full support of edges and corners.

The biggest changes in the use of dry-set mortars for installing larger tiles are the methods in which mortar is troweled on and bedding of the tiles into the mortar relative to the direction of the trowel ridges.

Traditionally, dry set mortars have been applied with the notched side of the trowel in a swirling motion of the wrist and arm. This might be marginally acceptable for smaller tiles, however, where the swirls come together or cross, air is trapped and larger masses of mortar are formed than is present in a straight trowel ridge, making it difficult if not impossible to disperse the mortar uniformly to produce even surfaces with larger tiles.

Photo courtesy of Custom Building Products

Radiant Heat Issues for Tile and Stone Installations

Problem	Cause	Cure
Tiles tenting off substrate	Lack of sufficient perimeter and field movement joints. Lack of a crack-isolation membrane	Follow recommendations for Movement Joint Design Essentials EJ171 in *TCNA Handbook*. Use a crack-isolation membrane (CIM) and follow manufacturer's recommendations. Install a CIM over the heat system to help allow for thermal expansion.
Excessive tile lippage problems	Lack of mortar or poured cementitious underlayment used to encapsulate the radiant heat system. Cable or tubes are floating above the top of the mortar.	Securely attach the radiant heat system so it stays flat on floor and cover the system with sufficient mortar or self leveling underlayment cement, 3/4” of dry pack or 3/8” FHU/SLU over the system. FHU/SLU may only need to be 1/4″ over the tube. See mortar manufacturer for this measurement. Use a quality contractor to install the system and tile.
Grout or mortar system is very powdery or weak.	Provided the grout and mortar system was properly mixed and installed, the main cause would be running the radiant heat system before the cement based products are allowed to cure a minimum of seven days. Excessive moisture from the slab may impact mortars or FHU/SLU. Test for moisture in the slab prior to installation.	Make sure all parties involved with the radiant heat system know the system cannot be put in service until the installation products are allowed to cure.
The thermostat "trips" when the electric radiant heat system is turned on.	The most likely cause is from a "short" in the system.	Make sure care is taken during the installation to avoid placing buckets of mortar over unprotected heat cables as this could crush the small cables. Avoid compromising the heating system with staples or other fasteners or damaging the insulation around the heating elements. Plastic lath MUST BE used with electric radiant system per National Electric Code. DO NOT use sharp instruments when cleaning mortar joints during tile installations. Grinders with diamond blades should never be used to remove mortar, grout or the tile itself. There is testing equipment to diagnose and trace a damaged wire or tube. The thermostat could have had a surge in the electricity and cause damage to the switch. If the switch does not reset when you reset the switch, it is prudent to remove the switch and test the cables or mats for continuity. If you have continuity in the wires, then chances are the switch is bad.

Problem	Cause	Cure
The thermostat overheats or even melts when the radiant heat system is turned on.	Damage of this type generally is caused by overloading the circuit, trying to heat too much floor area on one thermostat or running a 120v thermostat on a 240v circuit.	Make sure the radiant heat system is matched in terms of voltage and sized correctly to the circuit capacity and thermostat. It also could indicate the wire nuts are not sufficiently tightened. Make sure a licensed electrician makes the final connection.
The radiant heat system doesn't heat up.	The main reason for this is a broken or severed heating element.	Take care to protect the heating system during installation. This problem will require splicing/repairing the heating element. It is mandatory to test for continuity during the installation process and most importantly at the final electrical connection.
The radiant heat system heats up slowly.	Lack of insulation under the heat system may cause loss of heat to concrete subfloor. There are thin insulation membranes on the market that can be used to help control some of the heat loss to the slab. Insulation could play a role in the initial warm up. The heat system is too small for the area to be heated.	Install the system as designed for the surface area per the manufacturers recommendations.
The radiant heat system doesn't provide evenly spread or consistent warmth.	The main reason for this is varying or wrong spacing of cables or tubes	Follow manufacturer's recommendations for sizing and spacing.

Photo courtesy of NTCA Member Star Tile & Stone LLC.

NOTE: Most applications do not or may not require insulation materials, which would be an extra height restriction and cost issue. When using an insulation membrane under a heat system, refer to the insulation manufacturer for the correct application.

Prerequisites and Considerations for Successful Balconies, Courtyards, Patios, Plaza Decks, Roofs, Exterior Walking Surfaces and Swimming Pool Decks

Exterior tile decks are beautiful and easy to maintain when properly detailed and installed. When done incorrectly and with little attention to detail, they will fail. The *TCNA Handbook* notes that these exterior installations, like methods F103 and F104, may not perform in freeze/thaw climates.

Over occupied or unoccupied spaces, leaking can often lead to destroying property and commonly resulting in the decomposition of building components and framing members of the building. Ponding water on decks supports bio-organic growth, creates slippery traffic conditions, deterioration of ceramic and stone installations and efflorescence. To prevent ponding water, an uninterrupted minimum 1/4″ per foot positive drainage slope must be included in design and installation, both at the waterproof membrane and finished tile surface.

The following recommendations are critical for exterior decks, balconies, lanais and walkways. Most of these points should be considered prerequisites that must be met before an exterior installation should be considered.

Critical elements that must be considered:

A. How much height is available between the appropriate deck/balcony sheathing and all door sills? What type of installation; a thin-set or mortar-bed installation? Will there be enough height allowance for the 1/4″ per foot slope at the thresholds? Consider approximately 6″ above finished surface to allow appropriate waterproof flashing on the vertical surfaces.

B. Can the waterproofing cove up and terminate behind the exterior wall finishes? It includes the coving of waterproofing up the wall into a reglet type flashing under the wall finish materials. This way rain draining down the wall will run onto the top surface of the tile, instead of behind it.

C. The mortar bed is tiled using a premium latex modified thin-set. It is required by industry standards like ANSI A108.5 and critical to any exterior installation of tile that the coverage of the thin-set be no less than 95%. If voids of thin-set exceed the industry requirement, they will often accumulate moisture or water. In freeze/thaw climates, this water can freeze and expand, causing degradation and bond failure of the thin-set.

D. Determine that the temperature fluctuations comply with the different manufacturers' requirements during installation and typically a minimum of 72 hours thereafter. Extended cure times may be required for mortar bed installations to allow for elimination of excess moisture prior to subjecting installation to freezing temperatures.

E. If inclement weather is expected can the installation area be protected and/or enclosed?

If the above prerequisites can be met, then consider the following for your installation:

1. Drains with weep holes must have the waterproof membrane wrapping into the clamping ring of the drain assembly. A secondary overflow drain should be used to accommodate water when the primary drain gets clogged up with leaves, debris, etc. that may prevent proper drainage. All moisture above membrane systems in mortar beds is drained through the weep holes located at the sealing flange of two stage drains.
2. The finished tile surface and waterproof membranes should slope to the drain and/or away from the building structure.
3. When water is drained off the side of the deck, the wall surfaces and other areas of exposure will tend to stain and will require continual maintenance. If a gutter drain system is utilized it can minimize maintenance. Have all surfaces slope toward the drain or edge of the balcony/deck a minimum of 1/4″ per foot.
4. Correct movement joints including isolation joints at perimeter walls. Install movement joints using a 8-12 foot grid at the highest midpoint elevation between the drains, and have a minimum 3/8″ width movement joint. The traffic grade sealant (ASTM C920) or prefabricated movement joints need to be a minimum shores "A" hardness of 35 or greater in traffic areas. Movement joints size and placement shall meet or exceed the method described in *TCNA Handbook* Detail EJ171.
5. Flashing at all perimeter walls, columns, and transitions shall typically turn up a minimum of 6″ above finished floor height on the vertical wall. Moisture in adjacent wall assemblies is required to drain to the tile and stone surface, including weep screeds for stucco wall assemblies including ventilated facades. Posts, pipes or other penetrations in the deck need to be flashed at primary membrane, and then isolated and sealed with an appropriate ASTM C920 sealant.
6. Tile and stone installations are installed in accordance with ANSI standards; ANSI A108.1 for mortar bed method and ANSI A108.5 for thin-set method. When using the mortar bed method, a drainage layer (example: drain mat) over the membrane allows for easy egress of moisture to the drain, scupper or outfall.
7. Consider a secondary membrane over the mortar bed to provide additional waterproof protection, to minimize efflorescence and to avoid spalling in stone. For any tile or stone bonded to a membrane, the membrane must meet the ANSI A118.10 requirements. The general contractor must be consulted to confirm proper application of flashings. Penetrations in decks, like handrails, are required

to be properly sealed at penetrations. If at all possible, have railings mounted on the side of the fascia or the underside of the balconies. NEVER PENETRATE THE PRIMARY WATERPROOFING, unless it can be properly sealed.

8. Rain gutters from roofs are recommended to be tied into drains to exit the structure. Rainwater egress is not permitted to flow across public walkways.
9. All installations should follow the *Natural Stone Institute (NSI) Dimension Stone Design Manual* requirements for anchored stone and *TCNA Handbook for Ceramic, Glass, and Stone Tile Installation*.
10. Plaza decks are acceptable using pedestal-type systems. These are designed for severe weather conditions with the same requirements as above.
11. Walking surfaces should meet a minimum Static Coefficient of Friction of (SCOF) 0.6 per ASTM C1028 test protocol and a minimum Dynamic Coefficient of Friction of (DCOF) 0.42 per the BOT 3000 test protocol as described in ANSI A137.1-9.6-2012. Unless roofs are sloped to drain over roof edges, roof drains shall be installed at each low point of the roof. Roof drains shall be sized and discharged in accordance with the Uniform Plumbing Code. Overflow drains shall be connected to drain lines independent from the roof drain lines.
12. In areas subject to freeze/thaw conditions, do not install tile or stone subject to failure from freeze/thaw conditions.
13. Installation materials for ceramic tile and stone installed in demanding exterior, wet areas and submerged applications, must be allowed to sufficiently cure prior to exposure to water/weather.
14. Adjacent landscaping should have adequate drainage to accommodate high usage water flow. Slip, trip and fall hazards should be eliminated wherever possible. The property owners should plan maintenance on a regular basis.
15. Consult the local building code requirements. Refer to local building codes and product manufacturers for approved waterproofing or primary roofing membranes and flood testing as required.
16. In freeze/thaw climates, serious consideration for drainage mats is critical. Drainage mats help facilitate drainage from the tile assembly. It will also help reduce efflorescence and spalling.

DISCLAIMER: The tile contractor is not responsible for the design of the system. To avoid potential liabilities use a general contractor and certified roofing contractor when waterproofing over occupied living space.

Photo courtesy of NTCA Member Greg Twarog.

Submerged Applications

General Introduction

Tiling of water features, swimming pools and spas dates back to the Roman Empire. Since the early 1960s, swimming pools, water features, and spas have gained in popularity. Although there are many finishes available, tile has become increasingly more popular. For one thing, no matter what finish is selected, there is almost always a minimum of 6" of tile for the waterline of a swimming pool or spa. This can be easily cleaned and holds up in the harshest area of a pool where the tile below the waterline is cooled by the water and the tile above the waterline is in sunlight. So, why not just tile the entire structure? All tiled structures offer a lot of benefits and done correctly will last a lifetime and save costs.

Any experienced tile setter should be able to tile submerged structures, but there are several things that need to be considered. As most methods are the same as any traditional tile work, utilizing proper membranes, setting materials, and movement joints are critical.

Commercial or residential. Commercial pools come under the health department guidelines, and residential installation guidelines can differ. Depth markers need to be placed at certain locations and scum gutters typically only have a 1/4" maximum tolerance. Slopes must be maintained per local code.

There are many submerged application documents available to you, and it is important that you follow the guidelines. This document is not intended to replace *TCNA Handbook* Method P601, P602 or B-417, but help tile contractors understand the process. Documents that are referenced here are *NTCA Reference Manual*, *TCNA Handbook*, ANSI and ASTM.

Listed below are items the tile contractor must be familiar with before proceeding:

1. Types of structures
   Fiberglass
   Stainless steel
   Concrete block
   Formed and poured concrete
   Gunite (mixture of sand, cement, and water mixed at the nozzle and sprayed on structure)
   Shotcrete process of ready-mixed concrete applied with a pump truck

2. Types of tile and sizes (check with the manufacturer or supplier regarding suitability for submerged applications)
   Mosaics
   Porcelain
   Glass
   Natural stone
   Paper face or dot mount

3. Setting material (system warranty will give superior warranty)
   Mud beds
   Bond coats
   Adhesive Mortar
   Epoxy, cement, or other types of grout
   Waterproofing types pros and cons
   Cementitious waterproofing membranes for pool tank waterproofing
   ANSI A118.10 compliant waterproofing membranes
   Suitable flexible sealant (e.g. 100% silicone sealant) and applicable primers for movement joints

SINGLE-SOURCED MANUFACTURED INSTALLATION MATERIALS

Complex installations such as pools and water features [require] are recommended to be installed with high-performance installation materials. It is equally important to acquire all the installation materials from a single manufacturing source. This ensures compatibility with all layers of the installation system (including but not limited to: waterproofing; leveling mortars; adhesive mortars; grouts; and flexible sealants). In addition, many installation material manufacturers provide extended systems warranties for these applications when their full systems are utilized. Using single-sourced materials alleviates any finger pointing or issues with compatibility if an installation issue should arise. Also, when single-sourced systems are used on projects, the predictability of long-term performance is much more assured as manufacturers have tested their complete systems in accordance with applicable industry standards in these conditions.

Use the installation material manufacturer's recommended mortar to skim, patch, flatten, level or float, per the project specification requirements, to bring the substrate into project and industry tolerance requirements.

One of the most utilized installation materials on pools and water features is the mortar bed. Floating walls and floors are an important element to achieve an aesthetically-pleasing tiled finish in these applications.

Rendering mortars are used to float walls and used to screed floors. Using the right materials with the correct ingredient mix ratios is essential to the longevity and performance of the tile installation.

Traditionally, site-mixed mortars were solely used for these purposes in the various max ratios required for the application. However, modern manufacturing of rendering mortars has brought the cost down to a reasonable degree and has removed the job site mixing and ingredient variables that have plagued the use of site-mixed materials. These variables can include: varying degrees of water to polymer (or latex additive) to the sand/cement ratio due to the sand either being too damp or dry; inconsistency of sand-to-cement ratios; quality and cleanliness of sand delivered to the job site; quality and age of bagged Portland cement sitting on site; variability of graded sand aggregates, just to mention a few.

Therefore, using pre-packaged manufactured wall rendering, repair mortar or mortar bed material can alleviate many of the aforementioned issues and provides a high-quality, consistent blend of mortar that can reliably be depended upon for workability, consistency and ultimate performance. In many cases using pre-packaged rendering mortars can qualify for comprehensive extended manufacturer's systems warranties as they are part of a full single-sourced system.

Pre-packaged mortars use high quality products that are consistently manufactured and can typically be traced by batch or control number, which assures predictable quality assurance and performance.

1. Cold and hot climates
   • Providing a controlled environment will ensure predictable results. The controlled environment should be maintained until the pool is filled. Follow the manufacturer's recommendations for both mortars and tile.

2. Expansion and Control Joints
   • This is probably the most overlooked requirement. Water feature and pool installations can experience symptoms of failure before they are ever filled with water due to lack of expansion joints. Follow the guidelines of *TCNA Handbook* method #EJ171 for all installations.

3. New pool or renovation
   • Renovation will most likely need any existing material removed down to original substrate.

4. Proper start-up procedures, especially for saltwater systems
   • Fill/Emptying rates - Check with manufacturer for filling or emptying rate recommendations, often recommended to be no faster than 2 feet per 24 hours.
   • Wait a minimum of 28 days before starting the salt system
   • Water must be balanced

5. Checklist for pre-construction meeting
   A. Check around all inlets, etc., for voids or hollow spots
   B. Look for cracks, etc.
   C. Look for rebar showing.
   D. Has the pool been filled and water tested?
   E. Indoor or outdoor – what will the weather conditions be?
   F. Address what the conditions will be that will cause the work stoppage.
   G. Emphasize drying and curing times with written document.
   H. Have all safety barriers, etc., been installed?

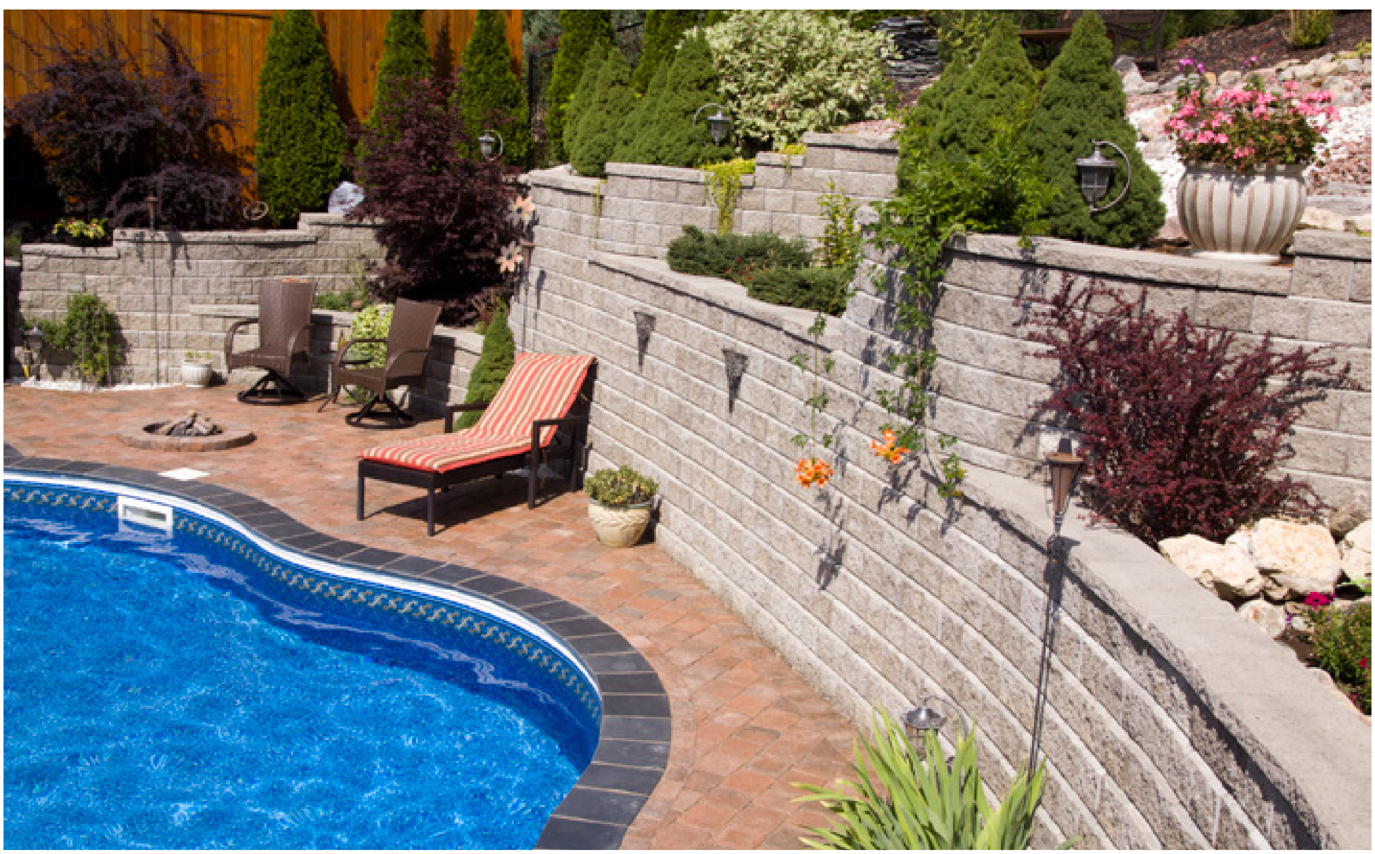


Photo courtesy of TEC Specialty Products.

Submerged Applications

Problem	Cause	Cure
Cracks and penetrations in the structure at joints and piping. Structural cracks result in reflective cracking and tile adhesion failures, and unsealed penetrations allow water infiltration beneath the tile and potential for delamination.	Cracking of tile or grout joints. Water leakage or delamination of tile near the penetration, joints or leakage.	Ensure proper water stop has been installed correctly, perform water leak testing and structurally repair cracks. Please note: this is not the tile setter's responsibility.
Delamination of the waterproof membrane. Penetrations causing leaks. Leaking/water seepage from pool tank.	Contamination of the substrate, concrete fines, or laitance. Pool tank cracks may exist, leaking at penetrations, high water table causing seepage in the pool tank.	Power wash or mechanically scarify the concrete. Do three standard bond tests insuring proper preparation of substrate. Ensure compatibility of any integral crystalline concrete additives or topical coating treatments with adhesive mortar manufacturers. Proper detailing of penetrations. Place pool tank membrane in accordance with *TCNA Handbook* methods as required.
Mortar delaminating from the substrate. Uneven/irregular structure surfaces. Hollow sounding areas – drummy mortars, spalling and cracking of leveling mortars.	Improper substrate preparation, use of improper mortar bed mixture, and/or installed mortar bed. Omission of proper mortar bed bond coats. Improper sequencing and installation of leveling mortars.	Use recommended mortar mix design or packaged, pre-mixed mortar. Use slurry bond coat to ensure adhesion of semi-dry mortar material. Careful attention to surface prep (pressure wash, water absorption testing); install control joints to avoid accumulation of shrinkage stress (fill jointing after mortar cure).
Tile cracking in joints or tenting. Failure will occur at the weakest point. Sometimes, entire sections of tile will crack and/or arch away from substrate. If expansion or contraction occurs during the curing cycle of the dry-set mortar, bond failure may occur with the matrix of the dry-set mortar. If curing of the dry-set mortar is complete and a good bond is obtained, failure will occur at the weakest interface, i.e., either at the substrate or at the tile.	Lack of movement joints. Weather causing thermal variations, causing expansion and contraction of tile and substrate, creates pressures that overcome the bonding strength of the setting material.	Install sealant in accordance with industry standards. Discuss with owner, engineer and pool contractor. Joints are much more critical in exterior pools and pools with glass tile and epoxy joint and in clad pools. Use sealants rated for submerged applications. Adhere strictly to *TCNA Handbook* – Expansion Joint Details, and to ANSI Specifications A108.01.3.0; Related Work Specified if details on plans or specifications do not specify locations for expansion joints, the architect should be notified of the ANSI Expansion Joint Requirements. If the architect still does not specify expansion joints, the tile contractor should initiate a letter of release of liability. The tile contractor should not assume responsibility for the design and location of movement joints.

Problem	Cause	Cure
Issues with rain/hot and cold temperatures can affect a number of things such as delamination, curing times and incomplete hydration.	Refer to Chapter 7 of the *NTCA Reference Manual* for cold and hot tiling.	Understand the conditions and plan ahead, providing shade and sometimes fully enclosed structures to maintain the proper temperatures. Make all parties involved aware. More time will be needed when these conditions occur.
Mosaics, mesh back or dot mounted tiles and glass tiles delaminating from the adhesive.	Tile that's not compliant or improper selection and not in conformance with ANSI A137.1 for ceramic and porcelain tile and ANSI A137.2 for glass tile.	Paper or plastic face-mounted mosaic tile recommended for pools to avoid adhesion incompatibility with water submersion. Inquire with tile manufacturer for test data, perform water soak and adhesion testing to ensure suitability of back-plastic dot or back mesh-adhesive mounted mosaic tile.
Cracking, delamination (hollow acoustic sounding) or adhesion failures of tile. Sandy/cloudy water after filling.	Premature water filling before cure of mortars. Aggressive water fill or drain rate (sudden water pressure or release). Extremes in fill water temperature (hot-cold).	Allow adequate mortar cure per manufacturer directions; protracted cure under cold temperatures and/or use high alumina cement thin-set formula for rapid/low residual water cure. Adjust fill water to tile assembly temperature to avoid thermal shock. Follow recommended fill and drain rates (1 inch/hr. max fill – 2 inches/hr. max drain).
Tile comes off clean, or with a small residue of dry-set mortar where ridges in dry-set mortar were in contact with tile.	Full coverage not obtained between dry-set mortar and tile, or dry-set mortar and substrate. Water penetrates and collects in voids, and upon freezing, forces tile to lose bond. Not all thin set mortars are suitable for use in submerged applications.	At least 95% coverage must by obtained between tile, dry-set mortar, and substrate in accordance with ANSI A108.5 on exterior installations, which requires 3/32 inch minimum thickness of bonding material and proper bedding. Use the appropriate adhesive mortar recommended by the manufacturer for submerged installations. Periodically check freshly-set tile for adhesive mortar transfer and coverage to ensure that the adhesive mortar has not skinned over and is achieving the desired coverage.
Deterioration, cracking and/or erosion of grout.	Inadequate cure time before water filling. Failure to install movement joints. Etching/roughness of grout surface from imbalanced water chemistry.	Utilize high performance grout (ANSI A118.7) or epoxy grout (ANSI A118.3) to eliminate chemical imbalance etching. Follow cure time requirements prior to water filling. Proper installation of movement and joints.

Submerged Applications

Problem	Cause	Cure
Cement based-grout etching/roughness, discoloration of grout, scale deposits on grout and tile, and deterioration of underlying thinset and mortar bed.	Water chemistry imbalance. Calcium depletion/weakening of cement, elevated water acidity, etching or deterioration of cement or elevated alkalinity deposits.	Please note this is not the tile installer's problem or responsibility to fix. Inform owner of maintenance importance in writing. A comprehensive water maintenance program should be put in place before water begins to go into the pool addressing such things as calcium imbalance, etc. Use installation materials that are more chemical and stain resistant, which are not as susceptible to damage from water chemistry.

Photo courtesy of TEC Specialty Products.

Photo courtesy of Emser

Shower Issues

Tub/Shower Combo and Prefabricated Shower Pans

Problem	Cause	Cure
Caulk/sealant with B.O.G. (Bio-Organic Growth/mold)	Negative corners on tub/pan ledges result in ponding water. Wrong type of sealant. Moisture penetrating grout and migrating down to caulk joint. Factory molded drain trenches inside of curb area are filled with caulk.	Use sealant meeting ASTM C920. Tub/pan must be properly supported and installed with positive slope to drain on all horizontal surfaces. Showers should be wiped down and allowed to breathe to eliminate any absorbed surface moisture. Repair or regrout and/or seal grout. Maintain sealant as necessary. Use exhaust fan after shower use to limit amount of indoor humidity. Remove caulk in factory molded drain trench(es).
Stains on tub/pan ledges.	Negative corners on tub/pan ledges result in ponding water. Excess moisture intrusion into wall assembly. Improper cleaning or maintenance. Use of pigmented bath products. Plumbing fixture leaks.	Tub/pan must be properly supported and installed with positive slope to drain on all horizontal surfaces. Maintain sealant as necessary. Regular cleaning and maintenance. Change types of bath products used to ones without pigments. Repair plumbing leaks.
Cracked grout at tub/pan joint.	Improperly supported tub/pan assembly. Use of wrong type sealant. Use of hard grout instead of proper sealant.	Use sealant meeting ASTM C920. Tub/pan must be properly supported and installed with positive slope to drain on all horizontal surfaces.
Cracked grout at corner joints.	Improper use of hard grout at corner joints/dissimilar planes.	Use sealant meeting ASTM C920.
Moisture leaks under tub/pan.	Use of non-flanged, prefabricated pan assembly. Use of self-rimming tub assembly in shower installation. Pan/tub water-stop flange terminates inside the pan/tub threshold leaving a void inside the shower door frame.	Do not use self-rimming tubs in any shower installation unless a flange kit is installed and warranted by the manufacturer. Flanges are required to be a minimum of 1″ high and extend past the center of the dam/threshold for use as a shower receptor.

Problem	Cause	Cure
Moisture intrusion at left and right front corners/leg, tub/pan installations.	Improper installation of tub/pan. Leaking shower enclosure framing or shower curtain issues.	Tub/pan must be installed true to plane/ level. Proper sealing and installation of shower enclosure framing. Refer to negative corner issues listed elsewhere. Refer to cracked joint issues listed elsewhere. Suggest replacing shower curtain with shower doors.
Ponding water on shower floor.	Unfinished floor surface not properly sloped to drain. Shower drain plugged.	Finished tile must be sloped a minimum of 1/4″ per foot to the drain and a maximum of 1/2″ per foot to drain assembly. Exception: certain ADA built shower floors.
Ponding water on horizontal surfaces of shower assembly.	Horizontal surfaces of the shower, such as seats, curb, pony-wall, window ledges, shampoo shelf, etc., are improperly sloped to drain assembly.	All horizontal surfaces must be properly sloped a minimum of 1/4″ per foot to the shower drain.
Slippery floor tile on shower receptor.	Use of tile or stone on shower receptor with COF of less than 0.60 rating. (Per ASTM C 1028).	Do not use glazed tile or polished natural stone with a COF of less than 0.60 rating. (Wet) (per ASTM C1028) Verify the tile used is warranted by manufacturer for use on shower floors. Use smaller tile modules to increase better footing. Regular cleaning and maintenance.
Dark wall sections adjacent to the shower floor.	Plugged weep-holes result in moisture retention in shower pan mortar; moisture migrates up wall assembly. Improper pre-slope in pan liner causing moisture retention in shower floor mortar bed. Certain glazed wall tiles can absorb water that collects in bottom rows and may flow off slowly due to caulk joints and impervious grout fillers as well as the very glazing of the front - so this is not only an issue caused by mortar beds.	Receptor membrane must be properly sloped a minimum of 1/4″ per foot to drain assembly with weep-holes. Verify that the weep-holes are open and use prefabricated weep-hole protectors, pea gravel or crushed tile or stone to cover weep-holes prior to installation of the dry pack mortar. Membrane should return up the wall a minimum of 3 inches above shower curb.
Dark area around shower drain grout and/or natural stone.	Use waterproofing in conjunction with properly functioning weep-hole assembly. (NOTE: May not be possible in all applications.)	Verify that the weep-holes are open and use prefabricated weep-hole protectors, pea gravel or crushed tile or stone to cover weep-holes prior to installation of the dry pack mortar.

Shower Issues (Tub/shower combo and prefabricated shower pans)

Problem	Cause	Cure
Cracked tiles on walls (Indent fractured tiles) – Mortar Bed	Improper installation of membrane and reinforcement. Improper wall supports or movement of wall supports. Improper overlap of membrane and wire. Improperly mixed mortar.	Properly prepare walls to receive mortar mix. Verify framing members are properly secured. Properly mix mortar to manufacturer's specifications. Properly install mortar in plane (flat). Re-design.
Cracked tiles on walls (Indent fractured tiles) – Backer board	Installation of backer boards does not follow the manufacturer's instructions. Check manufacturer's specifications for structural strength. Weak mortar used in taping CBU joints.	Install backer boards per the manufacturer's explicit installation instructions. Make sure framing is spaced no wider than 16 inches o.c. Wall board transitions and corners must be reinforced and installed tight and even. (NOTE: Some mortars may not be strong enough to be used for taping CBU joints.) Re-design.
Cracked grout joints in floor.	Plugged weep-holes. Lack of movement joints at perimeter. Improperly mixed or applied mortar. Improper setting of tile into thinset mortar bed. Mortar has started curing before tile is set. Improper sub-floor construction.	Receptor membrane must be properly sloped a minimum of 1/4″ per foot to drain assembly with weep-holes. Verify that the weep-holes are open and use prefabricated weep-hole protectors, pea gravel or crushed tile or stone to cover weep-holes prior to installation of the dry pack mortar. Use sealant meeting ASTM C920. Mix mortar bed to mortar bed specifications ANSI A108.1. Refer to page 106. Set tile using appropriate thinset adhesives applied in sufficient coverage and set tile firmly into setting bed. Mix and apply grout as per manufacturer's recommendations and according to the tile's requirements.
Plumbing penetrations/leaks.	Leaving too large of an opening for the plumbing fixtures. Improperly strapped/supported fixtures. Improper sealing of fixtures. Poor installation or tearing of wall membrane at mixer and/or spout locations.	Check the size of the fixtures prior to beginning the tile installation. Plumber is responsible for proper installation of rough plumbing. Sealing of valve/mixer escutcheons or spouts require that they are sealed 360 degrees around. The bottom 1/3 of the escutcheon or fixture must be left open to allow trapped moisture to migrate back to the shower drain and not build up and flow into the wall cavity. Re-design.
Moisture intrusion at curb.	Shower enclosure framing installed toward front of finished curb assembly. Receptor float retaining moisture.	Proper sealing and installation of shower enclosure framing with no penetrations into waterproof membrane. Shower framing should be installed on the inside 1/3 of the properly sloped, finished curb surface.

Problem	Cause	Cure
(continued from previous page)	*(continued from previous page)*	*(continued from previous page)*
Moisture intrusion at curb	Weep-holes plugged. Receptor membrane not properly sloped to the drain weep-holes. Curb membrane not sufficiently sloped to the weep-holes. Receptor/wall/curb joint cracked. Mortar installed against bathroom wallboard, sub-floor, or unprotected front of curb framing.	Weep-holes must be properly protected. Curb membrane must be sufficiently sloped a minimum of 1/4″ per 3-1/2″ to the weep-holes of the drain. Wall/curb joints must be sealed using sealants meeting ASTM C920 specifications. Glass door hinges and frames/tracks fastening points penetrate waterproofing and are not properly sealed. Glass door too heavy for framing. Re-design. Mortar cannot be installed against unprotected drywall, OSB or plywood subfloor or curb framing materials. Any material adversely affected by moisture must be protected by a proper membrane. Receptor membrane must cover the entire curb framing and project out into the subfloor. Mortar and tile at the front of the curb must be installed over an approved membrane. The wall membrane must cover the bathroom wallboard edge completely.

Preformed Shower Receptor Guidelines

In recent years several manufacturers have introduced Preformed Shower Receptors. These receptors, for the most part, are designed to replace the requirement for the Mortar Bed or Dry Pack. Some may even eliminate the requirements for the installation of the waterproofing membrane itself. Some key points to consider regarding these bases:

- Use only products designed for the application
- Follow manufacturer's written directions
- Check the floor for level
- Dry fit receptor and check for drain alignment
- Make sure product is properly embedded to floor with proper bonding agent per manufacturer's directions
- Install wall board per directions (before or after receptor)
- Note any tile size requirements/limitations
- Tile bonding agent requirements – Check with manufacturer's recommendations
- Grout requirements – Check with manufacturer's recommendations
- Use ANSI A118.10 waterproofing membrane (when required)
- Note any special drain requirements
- Verify plumbing/building code requirements prior to installation of the preformed shower receptor and waterproofing (Product file number, installation trade requirement, etc.)
- After installation perform flood test per manufacturer's written directions

Use only products designed for the application. Photo courtesy of Noble Company.

After installation perform flood test per manufacturer's written directions. Photo courtesy of Schluter Systems.

Photo courtesy of Cosentino

SAMPLE LETTER FOR GC OR GLASS INSTALLER

Date

General contractor/glass installer
Address
City, State, Zip

RE: Project
Glass enclosure and waterproof systems

Contact:

Do not drill holes in any horizontal surface, including the top of tiled curbs, shower seats and knee walls, as this will compromise the waterproof system used in this tile/stone installation.

Use epoxy or other adhesives to attach hardware at horizontal surfaces. If, by the glass enclosure design, fasteners must be used on vertical surfaces, use a sealant complying with ASTM C920 to fill drilled holes before inserting fasteners.

Any other practice will compromise the waterproof system used in this tile/stone installation.

Please contact me with questions or concerns.

Name and Title
Company

SAMPLE LETTER FOR GC OR CONTRACTOR

Date

Client or construction company
Address
City, State, Zip

Re: Project
Use of windows in wet environments

Contact:

It has come to our attention that you are considering the use of (or have) wood windows in your project that will be a part of, or come in contact with, the proposed tile installation. We would like to provide the following insights:

1. Currently, neither the *Tile Council of North America (TCNA) Handbook for Ceramic, Glass, and Stone Tile Installation* nor the American National Standards Institute (ANSI) Specifications recognize the placement of any window type in a wet environment. As such, there are no standards, details, or best practices within the tile industry that would instruct the qualified tile contractor on the step-by-step process that would yield a satisfactory and warrantable installation.
2. Wood windows should be avoided in tiled, wet location installations. These areas include, but are not limited to showers, steam showers, tub surrounds, or other tiled installations where water and high amounts of moisture will be in contact with the wood window for prolonged periods of time or on a continuous basis.
3. The inherent problem is not that the wood will get wet, but rather that it stays wet and cannot fully dry. These types of environmental conditions allow fungi, which are ever present in the air and soil to attack the wood fiber. This attack leads to deterioration of the wood, which is referred to as rot and possibly bio-organic growth (example, mold). These fungi feed on the wood and flourish in warm wet environments like showers, which will speed up the rotting process.
4. Efforts to protect the wood window by priming and painting all surfaces and installing the window in a sealant bead with flashing tape may be taken. However, even with ongoing maintenance, the window will inevitably move connecting wood joints, allowing the wood to absorb and trap water beneath the paint to start the deterioration process. Therefore, the use of wood should be avoided if a window is designed into a wet environment.
5. ***If a window is desired, the better alternative would be to use windows constructed from materials that are unaffected in wet areas.***

Name and Title
Company

SAMPLE LETTER FOR THE TILE CONTRACTOR

Date

Contact
Address
City, State Zip

RE: Project
Recessed glass in tile

Contact:

Aesthetic demand is increasing for shower enclosures to incorporate recessed (frameless) glass in tile partitions. This can be an attractive aesthetic option. However, great caution needs to be exercised to prevent damage to topically-applied waterproof membranes and existing tile installation.

A variety of options exist to create this recessed glass detail including premanufactured profiles. Whether a premanufactured profile is to be used or not, it is imperative that the integrity of the waterproof membrane is not compromised at any point during the profile or glass partition installation. Also, a capillary break should be provided and be compatible with the topically-applied waterproofing membrane.

If recessed glass in tile is requested, a detailed drawing including materials to be provided and installed by each trade partner and installation sequence of assemblies should be agreed upon prior to execution of work by all responsible parties.

Please contact me with questions or concerns.

Name and Title
Company

SAMPLE LETTER FOR THE TILE CONTRACTOR

Date

Contact
Address
City, State Zip

RE: Project
Penetrations in completed waterproofed tile assemblies

Contact:

Shower enclosures, wet areas and exterior waterproofed tiled conditions frequently include fixtures and accessories such as shelves, seats, sliding and frameless glass or acrylic shower enclosures. Great caution is required to prevent damage to waterproofed tile assemblies from penetrations through the waterproofing. It is the responsibility of the fixture or accessory installer to assure that any penetration through a waterproofing membrane is repaired per the recommendation of the waterproofing membrane manufacturer, so it does not affect the performance or longevity of the completed tile assembly.

A variety of options exist to accommodate recessed glass, shelves, recessed nooks and seats that are incorporated into the tile assembly that will not impact the integrity of the waterproofing membranes. Consider profiles, tracks and channels set into the tile, so waterproofing membranes are not compromised. Avoid penetrations through waterproofing whenever possible.

If accessories are requested by the design professional, a detailed drawing is necessary indicating what materials are to be provided and installed by each trade partner involved. Prior to installation, proper sequencing should be determined by all involved parties to assure the installation is executed correctly.

Please contact me with questions or concerns.

Name and Title
Company


GAMEDAY
EXPERIENCE
RETIRED
NUMBERS

Photo courtesy of LATICRETE International

Pebble Shower Floors

Precautionary Statement

The tile and stone industry has benefited from the popularity and growth of pebble mosaic and other irregular shapes of river rock, marble, glass, and stone. While this outdoorsy look is trendy and different, it can be a very challenging to the tile contractor installing it.

The surface of these mosaics can be flat or rounded, much like those found in nature. Because of the unique shape of these mosaics, and the way they are mesh mounted, it can be very difficult to blend them without exhibiting irregular grout lines or the grid of mosaic sheet lines from one sheet to the next. For this reason, a mock-up is recommended for approval by the owner. When the mock-up is not acceptable, some installers cut the mesh upon which the mosaics are mounted, or frequently remove stones or tiles from the sheets to blend them together and not be constrained by the mesh mounting. Most would agree, the result is better looking, but also very time consuming and costly.

INSTALLATION CONSIDERATIONS:

- When installing river rock or stone pebble mosaics over a foam-based shower pan, you should consult the manufacturer to see if these types of material are acceptable regarding point loading.
- The plumbing code in most jurisdictions requires a minimum slope to drain of 1/4" minimum from the farthest point per 12" of run, maximum 1/2", to facilitate better water flow to the drain around the pebbles and irregular shapes, but additional slope may be needed. Consult your local building code authority for maximum allowable slope.
- For proper adhesion, the bond coat of thin-set mortar must be applied thicker than normal to make contact with the irregular shape of the stone, while at the same time not come up too high into the joint. To do this, use the flat side of the trowel to collapse the mortar ridges to achieve a smooth, consistent setting bed. For additional information refer to the "NTCA Trowel and Error" video.
- Normally, the shower floor tile is installed first followed by the wall tile. When using pebbles, this will require a significant amount of time and installer expertise to scribe the bottom row of wall tile to the pebbles and will increase the cost of installation. Alternately, the wall tile may be installed first with the pebbles cut to the wall with the appropriate and consistent joint width. Either way, the installation of the 100% silicone sealant can be a challenge, which again, requires more time and skilled labor.
- Care must be taken to arrange and cut edges of the pebble or stone at drains, curbs, and any other terminations to avoid sharp exposed edges.

GROUT CONSIDERATIONS:

- The irregular depth and width of the grout joint makes estimating how much grout will be needed difficult.
- Frequently in these types of installations grout joints can exceed 1/2" in width and the same in depth. In addition, since the grout widths are irregular, they can be difficult to use with grouts that remain soft during installation and clean up, like ready-to-use grouts or epoxies. These installations must be approved by the grout manufacturer and should be installed only by a professional familiar with these grouts.
- The irregular surface makes cleaning during installation of the grout very time consuming and often inconsistent. When grouting these types of materials – depending on how full you leave the joint or how much is removed – you can yield a different appearance and feel.
- When the end user is looking for a lower grout joint exposing more of the pebble for a therapeutic feel, they need to be aware of the potential of pooling water between the stones, leading to discoloration and potential mold/mildew. The river rock or stone pebble mosaic can be an attractive look, but many find them uncomfortable to walk or stand on and are looking for a fuller-looking joint that doesn't expose as much of the pebble.
- The grout can also take a longer time to dry out, due to the mass of grout between tiles. This can delay the return to use.
- Stone mosaic tile could be pre-sealed to ease the cleaning and reduce potential for staining.

While this popular trendy look continues to grow, the irregular shapes of river rock, marble, glass, and stone present some challenges, so planning and mockups can be critical for success and the customer's approval. For your best opportunity for success, these mosaics should be installed by an experienced professional with knowledge of these installations, the best materials to use, and how to get them to drain properly.

Photo courtesy of NTCA Member Robb Olson of Footprint Wood & Stone

Steam Rooms

Problem	Prevention	Cure
Moisture/Mold on outside of perimeter wall. Dew point must be considered in the construction of a steam room. One side of the wall will always be considerably warmer than the other side. Where the warm air and the cooler air meet, moisture condenses, generally on the cooler side or outside of the perimeter wall. This is regardless of whether the wall is an outside wall or not. This constant formation of moisture on the outside of the steam room wall is the main cause of mold and mildew in the cavity wall.	Providing a thermal break on the side of the interior of the Steam Room wall separates the two areas' environments and stops the transfer of heat to the wall studs and wall cavity, thus negating the dew point. Steam rooms must also be water and vapor proofed. Options are to use a proper vapor barrier over the insulation on all load bearing structures of steam room except floor, place vapor barrier on warm side of insulation, and ensure vapor barrier connection to shower floor base liner as well as waterproof fastener spots and seams of sheet vapor barrier. Alternatively, a topical waterproofing material can be installed over all tile substrates if it inhibits sufficient vapor resistance properties (max. 0.5 permeability [perms] or 0.1 perms in continuous use steam rooms). Topical waterproofing with higher permeability ratings must be installed in combination with a vapor barrier and shower base liner as outlined above.	Re-design steam room.
Water dripping off ceiling of steam room.	Allow for minimum 2″ per foot slope on ceiling.	Re-design steam room.
Mineral build-up on surface of steam room.	Use water softener/mineral eliminator type prior to steam unit and advise users of need for continuous maintenance. Use setting materials and tile/stone not prone to contributing to efflorescence.	Consult water purification professional or steam generator manufacturer and design water filtration prior to steam unit.
Build up of slime or organic material on tile surface.	Use clean water and adopt the correct cleaning purification process.	Consult with cleaning professionals to design a cleaning process best suited for the water used in the steam unit.
Water leaking out of steam room.	Use correct method to waterproof corners and vapor proof walls – pay attention to detail at floor to wall transition.	1. Test water and vapor proofing design and products specified. 2. Make sure to eliminate water source as a potential of leak. 3. Check all penetrations such as but not limited to lights, switches, steam inlet, doors and seats. 4. Consult with design professional on dew point and insulation placement with regard to condensation. Re-design condensation collection point at shower pan. 5. Consult membrane manufacturer for test data and re-design steam room.

Problem	Prevention	Cure
(continued from previous page)	*(continued from previous page)*	*(continued from previous page)*
Moisture penetration through ceiling assembly.	Consult architect prior to install for proper lighting and insulation needed.	Refer to 1-5 on previous page. Re-design steam room.
Cracking at corners or changes in plane.	Provide slip joint detailed by vapor material manufacturer.	Refer to 1-5 on previous page. Re-design steam room.
Condensation building up in wall assembly.	Consult architect on specific dew point and placement of vapor/insulation assembly.	Refer to 1-5 on previous page. Re-design steam room.
Penetrations leaking vapor.	Vapor membrane manufacturer detail penetration prior to install.	Re-design either vapor barrier or insulation specified. Re-design steam room.
Moisture degradation at door assembly.	Provide proper steam door, consult manufacturer on specific installation details (coordinate vapor barrier and door manufacturers prior to install). Treat door area as a wet area. Use proper materials to eliminate moisture problems.	
Sealant degradation.	Provide proper sealant designed for steam rooms, install per manufacturer's recommended detail.	Remove sealant and replace with properly designed material.
Low/deteriorated grout joints.	The use of harsh chemicals may be needed to clean minerals or poor water chemistry. Use chemical resistant grout.	
Tile glazing deterioration at steam inlet.	Use proper tile in steam room environment.	
Deteriorating stone and/or tile.	Use proper stone and/or tile. See detail on Natural Stone Tile Selection and installation guide in *TCNA Handbook*.	Re-design steam room.
Water leaking through wall joints at door.	Consult with manufacturer for proper steam room detail.	Consult with vapor and door manufacturer for proper detail. Determine whether condensation or water leaking out of steam room is the root cause and re-design steam room. Provide a surface capable of holding up to moisture such as tile directly outside of steam door, include water/vapor membrane.

Precautions in Mitering Tile and Stone

Trim pieces are increasingly becoming unavailable or are not being made at all by many manufacturers in the new looks and types of materials being produced. Examples of these materials are encaustic cement, glazed porcelain, and glass tiles along with gauged porcelain tile panels. As a result, mitering is being used as a solution at the intersection of the pieces of materials.

Miters are typically used at wall returns, outside corners, curbs, benches, columns, recessed niches, and waterfall edges. The concern has become that miters have been taken to a level of tightness that, even though considered a mark of craftsmanship, the possible hazards to the end users and the longevity of the miter itself are being overlooked.

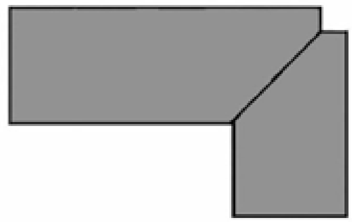
The inherent nature of the materials being mitered often creates a sharp edge. This is especially true in wet areas where the possibility of slipping and falling could increase the chance of coming in contact with these mitered edges. This is also possible at decorative columns where this condition may also be present.

When installing a mitered material, it is difficult to achieve full support through the mitered edge. This leaves the outer edges of the miter vulnerable and prone to chipping and/or breaking. Abutting the mitered materials to achieve the support leaves little room for mortar or grout. This practice allows for unfilled voids in the joint in which water and debris could possibly intrude, causing detrimental effects to the installation and longevity that tile, stone, and glass installation are known for.

The use of metal or plastic profile edging offers another solution when tile or glass trim pieces are not available. They are commonly used in both floor and wall applications. They are available in different shapes and colors for both function and aesthetics. They are often themselves mitered at outside corners on base, on top of columns, and at angles where dissimilar types of materials meet the tile and/or stone installations. The majority of these profiles are manufactured from stainless steel, bronze, brass and aluminum. As such, when they are mitered, they can create a sharp edge.

As instructed in ANSI A108.02.4.3.3 installations are to be performed incorporating this directive: "Smooth cut edges. Install tile without jagged or flaked edges." Following this instruction, when an installation involves mitered edges there are a few options that offer safety and long-term installation integrity, allowing the installation to perform as intended.

Quirk Miter – These types of miters have been used in the stone industry for many years. The Definition as defined in Dimension Stone Manual Quirk Miter: An external corner formed by two stone panels with beveled (usually 45°) edges and blunted, finished noses to reduce the chipping vulnerability of the sharp edges that occur in a common miter. This solution offers a way to strengthen the joint, reducing its vulnerability to breakage, and eliminates the sharp edge



Fused Miter – These types of miters are formed by employing color matched epoxies to the miter to fuse them together. This combination allows the miter to be shaped and smoothed to a degree that allows the miter to be fully supported, thus increasing the integrity of the junction while decreasing the likelihood of breakage.

Profile Miter Edging – Profile manufacturers are producing trim pieces that mitered pieces can abut, which support the joint and often allows for grout to be inserted in the junction. These pieces can greatly facilitate better performance of the joint while providing increased damage protection from impact.

Profile Edging – Profile manufacturers are producing trim pieces that can replace the need for a miter. Many are made in various degree angles for numerous applications. Profiles often allow for grout to be inserted in the joint between the tile and the profile. These pieces can greatly facilitate better performance of the change of plane while providing increased damage protection from impact.

Profile Corners – These finished corner pieces are often offered by the manufacturers of the profile edging. When available, profile corners should be strongly considered as they provide a clean profile transition. Profile corners must be properly fitted to allow correct alignment of profile pieces and to provide room for grout.

Grouting Thin Brick

FIELD APPLICATION OF THIN BRICK

Thin brick is a slim brick veneer that can be as thin as 1/2". Some thin brick is cut from the faces of full bricks while others are manufactured to size without cutting. Many classic-style brick are now offered in thin brick format as well as thin brick with a glazed and/or decorated finish. When you consider the different facial textures, colors, shapes and patterns available, you ultimately realize there are many options available for thin brick. This increase in options and popularity has led to a growing market for thin brick installations, both exterior and interior.

Thin brick has the same look and appeal as full size brick, but the installation method is much different. The benefits of thin brick are their versatility and structural weight reduction. They can be installed on most any wall by a qualified contractor. A different skill set is required for thin brick than for full brick; it is more similar to tile and stone installation.

In this paper we will touch on installation and focus on the grouting methods of thin brick. We will discuss the methods of installing grout mortar into the joints and the different tooling methods, sometimes referred as *joint conditioning*. While this paper provides the basics, ultimately it will be advantageous for the installer to obtain approval of the final desired look from the end user by performing a small (4'x4' recommended) mock-up prior to proceeding with the thin brick installation. The mockup can be done with a variety of grout application methods to determine which one is preferred.

Types of Installation: A majority of thin brick installations are done on metal panels with a tab system or are pre-cast into assemblies that are then lifted or tilted into place. For more information on those installations, contact the provider of the panels or the Precast Concrete Institute (www.pci.org). This paper gives recommendations for "field applied" installations that are more like traditional tile installations where the thin brick are mortared onto a suitable substrate and then grouted. "Field applied" installations generally require a grout joint. Consult setting material manufacturer for mortar and waterproofing recommendations if an installation without grout is desired. Often the grout is tooled to give a shape similar to a full brick installation.

Grout Joint Size: One difference between thin brick and tile is the amount of size variation and, subsequently, the width of the grout joint. Joints should not be any smaller than 1/4" and often approach 1/2" to provide an aesthetic similar to a full brick installation. If any tooling will be done to the grout joint (see below "Installing Grout Mortar"), the tool must be sized properly for the grout joint. Because most grout is applied with a grout bag or manual/powered grout/mortar "gun," the size of the grout joint must coincide with the tip size of the applicator. Often spacers or spacing rope are used to maintain the grout joint during installation, but these should be removed prior to grouting. As with any installation of ceramic products, proper movement accommodation is required. Refer to the *TCNA Handbook* method EJ171 for details.

Type of Mortar: Often in the brick world, the word "mortar" is used for the material between the bricks. For thin brick installations, we will be using "mortar" as the material holding the brick to the substrate and "grout" as the material between the bricks. Because the number of substrates and environmental conditions encountered on job sites is endless, it is best to consult with the setting material manufacturer for your specific situation. In general, the same ANSI A118.1, A118.4, and A118.15 mortars that work for setting tiles will also work for setting thin bricks in similar environments.

Types of Grout: There are a variety of options for grouting thin brick; each has positives and negatives. Your installation products manufacturer can help guide you to the correct product for your situation.

- Traditional Mortars: Typically, when dealing with full brick installations, Type N ("Normal" mortar with low compressive strength) or Type S ("Special" mortar with compressive strength above 1800 PSI mortar are used between the bricks in place of a traditional grout. For thin bricks, Type N mortar should not be used because it is does not provide any flexibility and the grout joints are not deep enough to create a suitable bond. Type S is often used because it lends itself to "bagging" although it can also crack, spall, and effloresce over time when subjected to freeze/thaw conditions and moisture. Many companies offer "Pointing Mortar" blends specifically for thin veneer application systems, which may or may not have an "S" designation.
- Cement Grouts: Typical standard cement grouts used for tiling (ANSI A118.6 designation) are also frequently used with thin brick. These grouts are relatively inexpensive and lend themselves to "bagging." However, standard cement grouts aren't always the best solution for exterior or wet applications where thin brick is often used due to increased likelihood of efflorescence and spalling from freeze/thaw. A polymer additive may help in these situations.
- High Performance Grouts: An ANSI A118.7 High Performance Grout is typically recommended by setting materials manufacturers to minimize efflorescence and block water penetration into and through the grout. ANSI A118.7 grouts are not always easy to "bag." Some professionals argue the workability is not user friendly due to the fine aggregates that make up these grouts and in circumstances these grouts tend to cure too quickly. Some ready-to-use or epoxy grouts also may be considered depending on the service environment. While these grouts perform well, not all of them are easy to install with a grout bag.

INSTALLING GROUT MORTAR:
The facial make-up of the brick will determine the method used to apply the grout in the brick joints.

- Traditional, textured, non-waxed thin brick which typically simulates full brick the installer will most likely need to utilize either a grout bag (most typical) to install the grout or use the brick mason's "tuck point" (most frequently used for repairs) tool/method. The purpose for these installation methods is to minimize getting grout over the facial portion of the brick. Due to the rough texture and porosity of the traditional brick finish, if grout gets on the brick the installer will most likely be unable to get it out.

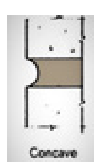
GROUT BAG


TUCK POINT


- Thin brick that has a smooth or glazed facial texture can be installed by the tile setter method with a traditional grout float. Bricks with a wax coating can also be grouted with a traditional grout float. The wax is then removed with a hot water, high-pressure spray.
- Sacrificial (wax based) grout release products can also be used with thin bricks that will be traditionally grouted. The wax covers the small voids and is removed during the washing step. Penetrating grout releases are typically not sufficient for this purpose. An approved mockup showing the final look achieved with the method being considered will help to eliminate issues once installation begins.

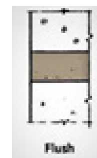
TOOLING THE JOINT
Once you have applied the grout into the joints you will need to tool the joint in one of the following manners. As the name implies, you will need a tool to create most of these looks.

- <u>Concave Mortar Joint</u> – By far, the most common joint used with thin bricks is the concave joint. This joint is made with the help of a curved steel jointing tool. This is a popular mortar joint type practiced due to its high resistance to rainwater penetration and tight sealing property. It is also the effect achieved by a traditional grout float.



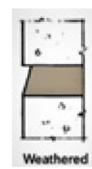
- <u>Raked</u> – Next in popularity is the raked joint. The joint is raked out leaving less space between the mortar joint and the face of the brick. Due to the ledge that is formed in the joint in a raked joint finish, this is best suited for interior walls only. Otherwise snow, ice or water will be held in the ledge of the joint penetrating into the wall. Care should be taken not to remove too much grout, no more than half of the thickness of the brick should be removed when raking.

- <u>Flush Mortar Joint</u> – This type of finished joint is just as it is named, the joint is finished flush with the face of the brick. This type of finish is typically desired if the end user intends on painting the entire, finished thin brick assembly. In this type of application, the installer can utilize the typical tile setter method of installing grout with a grout float.

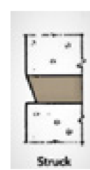


OTHER OPTIONS: While the concave, raked, and flush joints represent a vast majority of installations, there are other grout joints that can be requested. Typically, these require extra labor and may incur additional installation cost.

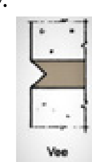
- Weathered – the top edge of the joint is recessed while the bottom edge is finished flat with the brick edge, shedding water from the joint.



- Struck Mortar Joint – the bottom edge is recessed while the top edge will be finished flat with the brick edge. The slope provided here will pull water and hold it in the brick, so it is best suited for interior walls only.



- V-Joint – this type of joint is made with the help of a curved steel tool with a "v" shaped end. Proper tooling of the v-joint helps to prevent water accumulation in the joint.



CLEANUP: Most ceramic thin brick can have excess cementitious mortar and grout removed with an acid-based grout removal product. Check with the thin brick supplier before acid cleaning glazed or decorated bricks. Do not use acid for cement-based bricks. Ready-to-use, epoxy, or non-cementitious grout will require a cleaning product specific to the grout chosen. A penetrating tile or stone sealer may be used for exterior installations or those exposed to water.

IN CONCLUSION: The intent of thin brick is to simulate the look of a traditional brick assembly without the structural components that go along with traditional brick modules. In simulating brick, we must understand the different brick joint profiles and how to achieve the final look of each profile, get clear direction from the end user which profile is desired, then prepare a mock up for final approval prior to proceeding.

Photo courtesy of National Ceramic Tile and Stone Corp. for Stanly Ranch Resort, NTCA Five-Star Achievement of Excellence Award winner for 2022 Commercial Elite Project of the Year.

8

MATERIAL-SPECIFIC INSTALLATIONS

Photo courtesy of NTCA Member Snowbee Custom Tile.

Chapter 8
Material-Specific Installations

Broken Natural Stone Tiles

Problem	Prevention	Cure
Insufficient or uneven bond coat coverage.	See page 116 "Proper Bedding Procedures." Flat back-troweling natural stone tiles.	Replace the broken tiles and correct the cause.
Improper bonding material.	Use setting materials that comply with ANSI specifications and methods detailed in the *TCNA Handbook*.	Replace the broken tiles and correct the cause.
Movement in substrate.	Proper placement of control or expansion joints (*TCNA Handbook* – "Expansion Joint Details" EJ171), and proper substrate preparation for the installation of natural stone tile, including the use of 2 structural layers for wood frame construction.	Replace the broken tiles and correct the cause, where possible.
Impact resistance requirement too great for materials selected.	Use thicker and/or more durable class of tiles if subjected to unusual impact or heavy loads.	Replace the broken tiles and correct the cause.
Insufficient bond caused by contaminated back surfaces. Natural stone and agglomerate tiles are subject to fabrication residue.	Adequately clean back of stone and substrate surface.	Replace the broken tiles and correct the cause.
Contaminated substrate.	Prepare substrate to industry specifications (scarify if necessary).	Replace the broken tiles and correct the cause.
Applied over slab cracks.	Treat slab cracks with isolation membrane before installing tile.	Remove affected tiles plus additional tile on each side of crack. Install isolation membrane.
Omission of expansion or control joints.	See *TCNA Handbook* – "Expansion Joint Details" EJ171 for treatment of expansion or control joints.	Remove damaged tile and install expansion and/or control joints in stone directly over substrate joints.

Lippage or Uneven Natural Stone Tiles

"Lippage" is a condition that occurs when adjacent tile edges are not flush with one another.

Problem	Prevention	Cure
Uneven substrate surface.	Prepare substrate surfaces according to "Proper Preparation and ANSI Requirements for Thin-set Method Tile Installation." *(See page 111.)*	Remove and replace high tiles. Grind and refinish tiles or replace tiles after grinding off substrate high spots. Fill low spots with self leveling underlayment or floor preparation underlayment. Floor should be refinished by qualified persons.
Insufficient or uneven coverage of the bond coat or mortar bed.	See page 116 "Proper Bedding Procedures."	Grind and refinish or replace tiles. Floor should be refinished by qualified persons.
Varied tile thickness.	Examine tiles to determine consistency of tile thickness. Use box screed for excessive thickness variation. Conventional mortar installation will minimize effect of varied thickness. Use a large and heavy tile (LHT) mortar.	Grind and refinish or replace tiles. Floor should be refinished by qualified persons.
Improper mixture or wrong bonding material.	Use materials recommended by the bonding material manufacturer for the desired installation. Mix according to manufacturer's instructions.	Grind and refinish or replace tiles. Floor should be refinished by qualified persons.
Insufficient leveling of each individual tile.	See page 116 "Proper Bedding Procedures."	Grind and refinish or replace tiles.
Warping caused by water (most green marbles and some other moisture-sensitive stones).	Set material with epoxy.	Remove and replace tiles. Floor should be refinished by qualified persons.

Lippage-Control Devices

Dos, Don'ts and Best Practices for Lippage-Control Systems

Lippage-control systems primarily used with large format tiles are specifically designed to help reduce lippage within the tile assembly.

Adhering to the *TCNA Handbook* and ANSI standards regarding substrate requirements of floor/wall flatness as well as ensuring uniform depth of mortar and EJ171 accommodations are critical and essential in providing sustainable large format tile installations.

The correct use of lippage-control systems will provide greater finish quality consistency by reducing the effects caused by variations in substrate porosity and job site climatic fluctuations and in some cases minimize warpage in certain tiles.

These systems are not designed or intended to fix poor craftsmanship or circumvent approved industry standards.

Lippage according to the ANSI standard A108.02, Section 4.3.7: "Lippage refers to differences in elevation between edges of adjacent tile modules." Variation in the height of adjoining tiles is called lippage. The growth of large format and plank tiles has accentuated the warpage produced in manufacturing these large tiles. Even rectified porcelain tile manufactured to the tight tolerances of ANSI A137.1 can exhibit up to -0.40% to -.05 in edge warpage due to the manufacturing process. These changes in size have increased the need for changes to standards and tools to minimize lippage. One of those "new" tools commonly used in large format and plank tile installations is edge or lippage-control devices. These devices, while beneficial to an installation, are new; directions are inconsistent and can be quite a learning curve for the installer.

Lippage-control devices are designed to be used in conjunction with the *TCNA Handbook* methods and ANSI Standards. These devices are to mechanically assist an installer as the last step of the setting process, to mechanically tune any remaining lippage, not to correct bad installation practices or conditions on a jobsite. All installations will require proper surface preparation, layout, and an adequate bond coat thickness/depth to support the tile and lippage-control devices.

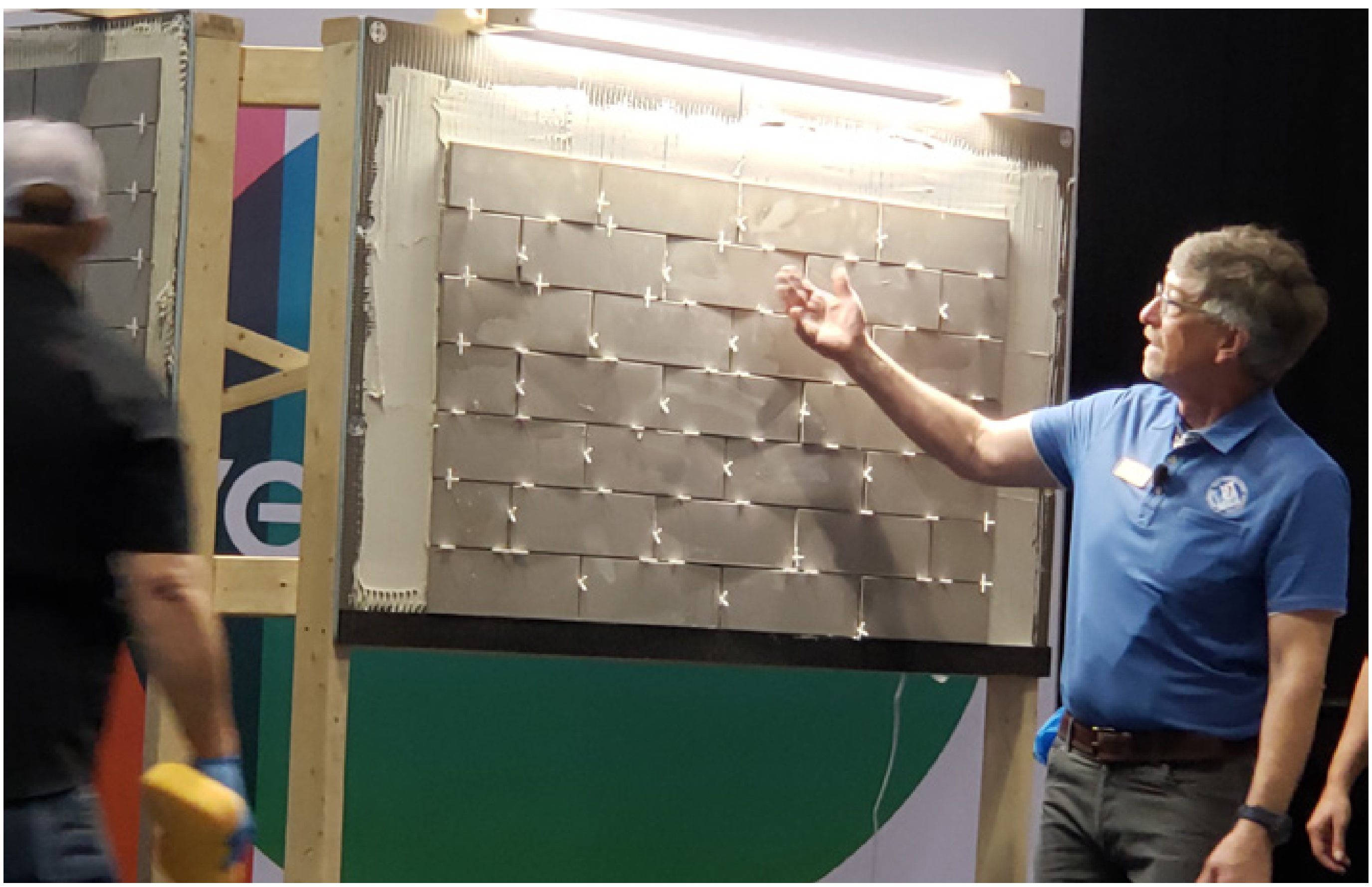


Photo courtesy of the National Tile Contractors Association

Edge and Lippage Mechanical Tuning Devices

The following list of dos and don'ts are intended to provide best practices for the use of these devices.

DOs	DON'Ts
Follow the manufacturer's directions.	Don't expect a lippage-control device to perform if not properly embedded. Have enough mortar to accommodate the device.
Follow *TCNA Handbook* methods and ANSI standards for substrate flatness. Complete proper substrate preparation to meet substrate tolerances previous to installing the tile and lippage-control device.	Don't forget to flat back-trowel large format tiles (tiles with any one side 15" or larger).
SSD (Saturated Surface Dry) the substrate prior to applying setting material.	Don't get on the floor too early. Follow setting material manufacturer's instruction for cure times in accordance with system removal.
Key the mortar into the substrate using the flat side of the trowel.	Don't assume you know how to remove the lippage-control device. Consult the lippage-control device manufacturer's instructions. Depending on the design of the lippage-control device, removing the lippage-control device improperly can increase the potential for damage to tile edges; use caution.

Variation in the height of adjoining tiles is called lippage. This is defined in the ANSI (American National Standards Institute) standard A108.02, Section 4.3.7: "Lippage refers to differences in elevation between edges of adjacent tile modules."

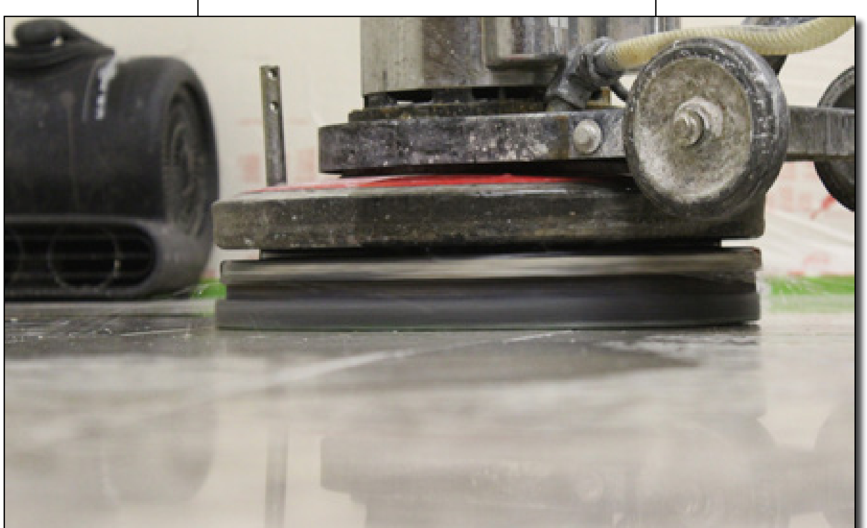
Edge and Lippage Mechanical Tuning Devices (cont.)

DOs	DON'Ts
Always use an appropriate sized notched trowel to achieve proper coverage.	Don't scratch tile or stone surfaces with dirty lippage-control devices. Be sure you use clean caps, wedges, rubber feet, or other accessories.
Follow the NTCA "Trowel and Error method" when applying setting material to substrate for installation of large format tiles. This will provide increased coverage, minimize air entrapment and assist in proper embedment of tiles.	Don't use a system where you can't remove the top part of the lippage-control device to allow proper cleaning of the grout joint. The ability to remove the top part of the lippage-control system after tuning is essential in order to allow for the proper cleaning of the grout joint, which prevents chipped or broken tiles from aggressive cleaning of the grout joint after the mortar is set. Setting material left to harden in the grout joint may also hinder smooth removal of the lippage-control strap/clip.
Always engage lippage-control devices after proper embedment of each tile has been achieved.	Don't expect a lippage-control device to correct a poor installation.
Place your free hand on high tile and push downward when engaging lippage-control devices.	Don't proceed with any installation that has not been properly prepared to industry substrate tolerance requirements.
Always ensure corners and edges are fully supported with setting material.	Don't expect a lippage-control system to correct all lippage problems in tile installations. Refer to *TCNA Handbook* and ANSI standards for acceptable lippage and pattern selections.
Ensure fresh setting material is deposited under as well as atop the fixed base plate, upon resuming an installation the following day	Don't forget to carefully review that the area around the strap/clip is clean before breaking the strap. Leaving mortar build up around the strap/clip can cause removal trouble and cause potential edge damage.
Do use spacers or grid lines for establishing the grout joint width. Never use the lippage-control system as the tile spacer, it could pinch the tile edges and cause damage to the tile or stone edges when removing. Always leave free space around the lippage-control strap/clip when installing.	Don't move the lippage-control device after it has been in place beyond the set time of the mortar. This will displace mortar and leave a void, potentially causing a failure in the tile.
Many lippage-control devices have different plates/straps/clips for different types of tile; one example is thin porcelain tile panels verses traditional porcelain. Use the appropriate strap/clip and base plate.	Don't place lippage-control devices in any combination of corners.

Photo courtesy of Sika Tile

Scratches and/or Dull Areas in Natural Stone Floors

Problem	Prevention	Cure
Use of stone that is too soft for the traffic.	Select a stone with an abrasion resistance that meets the industry's recommendations for the expected traffic, or offer a honed finish that is less likely to show scratching.	Refinish floor using products especially manufactured for that purpose. Potentially, regular maintenance will prevent the reoccurrence of the problem and provide a lasting serviceable finish. Floor should be refinished by qualified persons.
Exposure of floor to grit or abrasive traffic.	Keep floor clean by regular dust and damp mopping as a regular maintenance procedure, using a neutral pH cleaner. Dust mop daily with a non-treated mop. Designate one mop for each floor surface. Utilize walk off mats at high traffic areas.	Floor should be refinished by qualified persons.
Use of polished finish instead of alternative finished flooring.	Consider a honed, or other non-reflective finish surface in high traffic areas. Use entrance mat of at least 48" in length Keep floor clean by regular dust and damp mopping as a regular maintenance procedure, using neutral pH cleaner. Keep mats dry and clean. Replace mats as they wear out. Use mats on both the interior and exterior of the doorway.	Floor should be refinished by qualified persons. Apply appropriate sealer for desired color and appearance of marble/granite.
Use of sanded grout on polished stone.	For joints up to 1/8 inch use unsanded grout. (Some epoxy grouts may be used if recommended by the grout manufacturer.)	Floor should be refinished by qualified persons.



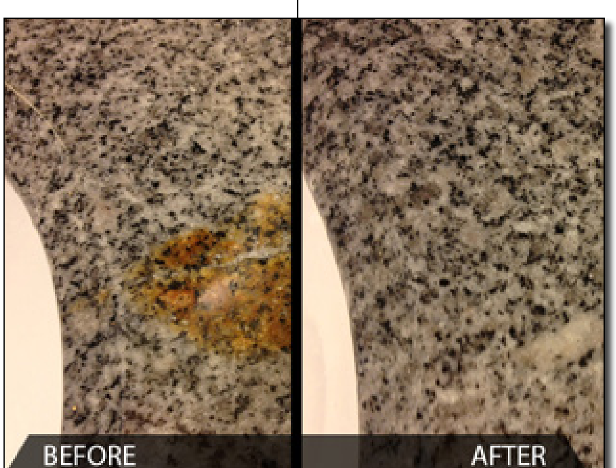
Etched or Dull Areas in Polished Natural Stone Surfaces

This section does not address stains associated with dull areas. See "Stains," (page 212).

Problem	Prevention	Cure
Exposure of calcareous stone surfaces to mild acid, such as found in fruits, vinegar, juices, and other food products commonly found in kitchen and food service settings. Exposure of calcareous stone surfaces to acidic cosmetic products or urine in bathroom settings.	Use coasters under glasses and food. Protect stone surfaces from cosmetic stains and spills. Clean all spills promptly. Protect polished stone surfaces with a topical sealer manufactured for that purpose.	Repolish stone with oxalic acid, tin oxide, or special polishing preparations as recommended by the manufacturer. Floor should be refinished by qualified persons. Concave areas and areas damaged by acid or urine may require grinding or replacement. Use honed or other non-reflective finishes, or use stone varieties with high abrasion resistance indices and chemical resistance. Floor should be refinished by qualified persons.
Cleaning solutions containing acids, alkalines or solvents used for both initial cleanup and ongoing maintenance.	Clean stone surface after installation with a neutral (pH7) cleaner. Rinse and wipe dry. Apply a sealer when necessary to help protect the surface.	Repolish stone surface with oxalic acid, tin oxide, or special polishing preparations as recommended by their manufacturer. Floor should be refinished by qualified persons.
Alkalinity of cement-based grouts.	Follow grout manufacturer's instructions. Remove grout residue from the stone surface as soon as possible following installation. Use a penetrating or impregnating sealer prior to grouting per manufacturer's directions.	Consult care and maintenance manufacturer for a recommended alkaline cleaner or specialty products. Repolish stone surface with oxalic acid, tin oxide, or special polishing preparations manufactured for that purpose.
White stun marks.	Choose denser stones or use stones that are not subject to acid attack. Stun marks are inherent in certain stone varieties and cannot be avoided.	Grind and refinish or replace tiles. Floor should be refinished by qualified persons.

Stains

Problem	Prevention	Cure
Absorption of materials such as paint, rust, food, tobacco, iodine, lead, ink, liquors, and oil-based products.	During construction, cover the installation with kraft paper, taping the joints and edges. For heavy traffic areas, apply a minimum of 1/4" plywood over the kraft paper. It is not the responsibility of the tile contractor to place the plywood. Refer to *TCNA Handbook* Section "Notes/Definitions" titled "Protecting New Tile Work." For ongoing protection, regularly apply a penetrating or impregnating sealer as necessary per manufacturer's recommendations. Do not allow contaminantss to come into contact with marble. Blot spills immediately with paper towels or rags for minimal damage. Wiping a spill may spread it over a large area, making a larger mess.	See "Stain Removal," (page 217).
Use of adhesives or other setting materials that result in "bleeding" through the stone to the finished surface.	Test questionable setting materials to determine whether they will penetrate the stone and stain the surface. Use only materials recommended for stone setting. The use of white thin set mortar of rapid cure setting materials might be necessary to avoid this issue.	Remove and replace the stone. A color enhancing sealer may be used. Poultice materials may be needed for stain removal, grinding may be required for some mortar deposit damage.
Mortar deposits and stains.	Clean the area immediately, removing the mortar deposit and residue.	**TEST INCONSPICUOUS AREA FIRST** to determine desired results. Floor should be refinished by qualified persons.



Protection and Maintenance of Natural Stone Floors

FLOORS
Traditionally, honed marble was used on floors in commercial and public establishments. A honed finish does not need refinishing as frequently as polished finishes, since foot traffic will dull the polish. In fact, a honed surface develops a patina through wear (honing caused by foot abrasion) that enhances the beauty of natural stone.

Polished finishes have long been used in residential applications, but are relatively new to commercial and public applications in the U.S. The use of polished finish on the softer stone varieties can be problematic in high traffic commercial applications.

When high gloss factory finishes have been abraded by foot traffic, the resultant effect is normally a non-uniform gloss level, since the abrasion occurs more rapidly in the heavily used portions of the floor. Restoration of this finish can normally be accomplished in-situ, but this is the work of professional contractors specializing in this field. Oftentimes, it is impossible to restore the floor finish to an equal level of gloss as the original product, since the portable equipment used by restoration professionals does not have the same capability as the production line polishers used by the factories.

PROTECTION AND MAINTENANCE
Two important and separate steps need to be considered:
a) initial protection using penetrating or impregnating sealers;
b) regular and periodic thorough cleaning using conditioners, polishes, impregnators or sealers, and mild pH 7-9 cleaners specifically formulated for use on natural stone.

Products used under both “a” and “b” should be slip resistant when dry: however, when wet, this slip resistance is frequently compromised.

INITIAL PROTECTION
Despite their high density, some natural stones have a level of porosity that is great enough to allow some staining agents (including the impurities found in the cleaning water itself) to penetrate into the pores to a depth that prevents surficial cleaning methods from removing them. An initial protection with an impregnator and/or sealer will usually lessen this vulnerability.

Most manufacturers of specialty chemicals for natural stone offer these two types of protectors to cover all of the different interests of customers and needs of the natural stone:

Impregnators, often also known as penetrating sealers, are designed to penetrate the surface and reside in the subsurface within the first few millimeters of the stone fabric. When properly applied, they will leave no residual coating on the stone’s surface. Impregnators are therefore suited for all surface finishes of natural stone (e.g.: polished, honed, and textured).

Sealers include topical coatings that bond to the stone surface and provide a sacrificial layer over the stone. Topical sealers are rarely used for natural stone surfaces. Because they are a sacrificial layer, they introduce a maintenance requirement of frequent reapplication, and they also will generally change the appearance of the stone and/or its gloss level.

Manufacturers’ recommendations must be followed in the application of any impregnator or sealer.

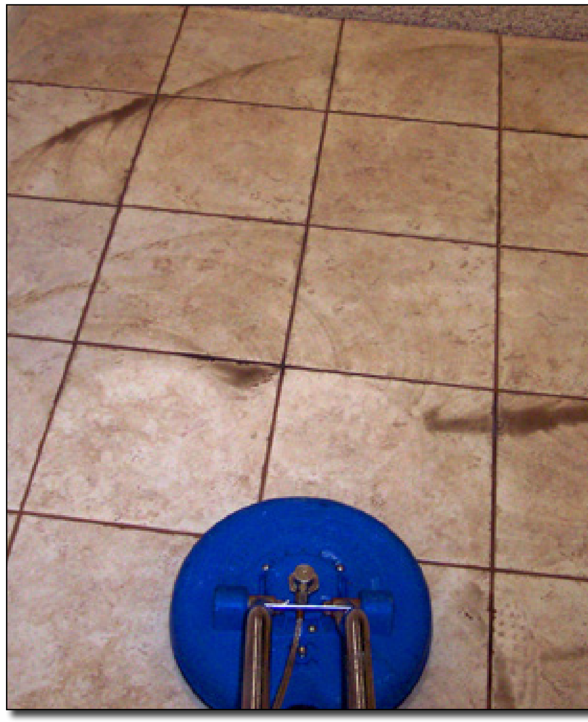
Some chemicals may be harmful to the health of occupants and/or the environment. Consult the manufacturer’s recommendations and carefully read corresponding SDS (Safety Data Sheets). Testing in an inconspicuous area is recommended.

REGULAR MAINTENANCE AND THOROUGH CLEANING
Once the floor is properly protected, daily or periodic maintenance becomes easier and the original stone appearance will remain for a longer period of time. Regular maintenance can be achieved by dust mopping, sweeping, or vacuuming when the stone becomes soiled. After all loose soil is removed, the stone may be further cleaned by using a pH neutral cleaner designed for stone cleaning. Using water alone for cleaning may not always be adequate. Water quality is critical, as contaminants contained in the water, such as chlorine, salts, and minerals, may lead to degradation of the stone surface. It is important that the cleaning solution is changed when dirty, and minimal water is left standing on the floor.

NOTE: Refer to other appropriate pages throughout the entire Chapter 8.

1. **Maintenance of Honed and Textured Floors**
   Regardless of whether the surface was treated with an impregnator, daily or more frequent dust mopping is recommended to remove harmful particles scratching the surface. Frequent damp mopping, using a pH neutral cleaner, allows you to mop off any surface dirt. Buffing is optional, though it may further improve the appearance of the floor. Periodically, a thorough and deep cleaning may be needed, using a low alkaline cleaner. Consideration should be given to adding a topical coating to honed finishes if a soft vein filled or soft veined stone is used. Always test this process first before proceeding with application.

2. Maintenance of Polished Stone Floors
Special attention must be given to the polish and procedures.



The regular use of special polish preservers and polishes, in addition to the daily pH neutral cleaner may not eliminate the need for periodic refinishing of the floor, particularly when soft stone varieties are used in heavy traffic areas. Refinishing of stone floors is a task that should be undertaken only by those contractors who specialize in this field and who have the proper equipment and experience.

Floors should be refinished by qualified personnel.

Some chemicals may be harmful to the health of occupants and/or the environment. Please consult manufacturer's recommendations and carefully read corresponding SDS (Safety Data Sheets). Testing in an inconspicuous area is recommended.

Photo courtesy of Daltile

Maintaining Polished Stone Countertops and Bars

COUNTERTOPS AND BARS
Countertops and bars pose a different set of circumstances for maintaining polished stone surfaces. Acids, alcohol, juices, and even water may stain, leave marks, or etch polished calcareous stone finishes. They also damage most wax finishes. When wet, waxed finishes on polished stone bars and countertops may become so slippery that glasses and other items tend to slide and often fall off the edges. Furniture polishes may perform better than waxes in some instances, but since they are not formulated for this purposed, the challenge of testing to determine suitability resides with the user. Siliceous stone varieties, such as granite or serpentine, are generally less problematic when used for countertops and bars. These stones have greater chemical and abrasion resistance, and as such, tend to be more durable than calcareous stones (e.g.: marble, limestone, travertine) and less likely to stain and become etched. Use of an impregnator or penetrating sealer is recommended.

Maintaining Polished Stone Walls and Base Molding

WALLS
Care of polished stone walls and base molding varies, depending on the severity of use in areas where they are located. Since food or drink spills are not likely to be encountered in wall applications, impregnators or penetrating sealers are generally not required. An exception to this would be wall surfaces where frequent hand or hair contact is expected, such as near elevator call buttons or walls behind benches, where skin oils will penetrate the stone surface and create staining issues.

On shower walls, use a squeegee to minimize soap scum. To remove soap scum, use a non-acidic soap scum remover or a specialty stone cleaner recommended for this purpose.

Photo courtesy of Miracle Sealants Company

Stain Removal from Natural Stone

COPPER AND BRONZE STAINS
Copper and bronze stains appear as green or muddy brown colorations. Remove stains with a thick paste poultice (consistency of peanut butter). The poultice consists of a powder with moisture retention ability, a fluid (either water or solvent based, depending on the stain to be removed), and possibly additional stain dissolving agents. Apply the poultice over the stain, and beyond the stain, and leave until dry. Remove with a plastic or wood spatula, rinse thoroughly and allow to dry. Repeat process if necessary to remove stubborn stains. Lead stains appear as yellow or orange colorations and may appear at a distance from the source. Lead is virtually non-reactive to chemicals. Lead salts that may form will be extremely difficult to remove. Generally, lead stains on exterior stone will fade in time after the source is removed.

STAIN REMOVAL
Most stains on interior polished stone generally will be caused by organic materials or oils and greases. When the source of the stain is unknown, try a poultice first. If this is ineffective, follow remedies described below, attempting each in turn until results are achieved.

ORGANIC, FOOD, TOBACCO AND URINE STAINS
Most organic, food, tobacco and urine stains respond in varying degrees to hydrogen peroxide (6 percent hair bleaching solution) or chlorine bleach (laundry bleach). Apply liberally to the stain. A blotter or sponge soaked in peroxide or bleach can be used. For stubborn stains or stains on walls, peroxide or bleach can be mixed with a poultice and left overnight or for a longer period of time as necessary. Rinse thoroughly with water. Use bleach with caution, provide ventilation and do not mix with ammonia. The combination of chlorine bleach (sodium hypochlorite) and ammonia produces gases that can be fatal.

IODINE STAINS
Iodine stains can be removed with a poultice of isopropyl (rubbing) alcohol, methyl (wood) alcohol or ethyl (grain) alcohol.

Organic – 12% hydrogen peroxide poured directly on the stain, add a few drops of ammonia. Leave until bubbling stops.

Iodine – Apply denatured alcohol and whiting poultice. (Whiting material can be plaster or laundry whiting.) Follow poultice procedures.

OIL, GREASE AND PERSPIRATION STAINS
Oil, grease and perspiration stains can usually be dissolved with acetone (dimethyl ketone). Lacquer thinner and clear mineral spirits are acceptable substitutes. Stubborn stains may also require a poultice or saturate a blotter with solvent and cover beyond the remaining stain. Allow the solvent to dry, remove the poultice or blotter and rinse with water.

INK STAINS
Non-metallic ink stains may be removed using a poultice or blotter soaked in wood or grain alcohol, followed by flushing with household ammonia. A bleaching poultice may be needed to remove remaining coloration. Stains caused by inks formulated from metallic salts can be removed by vigorous rubbing when fresh. Seated stains may be removed with the application of a commercial naval jelly or other rust remover. Stubborn stains may require application of a poultice containing household bleach. Apply for no more than a half hour, then flush at once with a sodium citrate solution and rinse with water.

PAINT STAINS
Paint may be removed with commercial-type paint strippers available from hardware and paint stores.

Mineral spirits may also be used to remove paint stains. Ink or magic marker stains can be removed using methylene chloride. Oil stains can be removed using ammonia or a degreaser.

These strippers normally contain caustic soda or lye and should be used according to the manufacturer's instructions and with recommended protective clothing. Flush profusely with clean water after use. Use only wood or plastic scrapers and stiff fiber brushes for removing the sludge and curdled paint. Normally, latex and acrylic paints will not stain marble. Oil-based paints, putty, and many caulks or sealants usually cause oily stains. These may be removed using methods described for removing oil and grease stains. (Refer to page 212.)

METALLIC STAINS
Metallic stains require treatment with a reduction agent that will attach the metallic salts and reduce them to soluble, colorless salts that can be rinsed away or drawn out by poultices. Metallic stains generally are found on exterior surfaces. Before attempting to remove metallic stains, determine the source of the stain. Then make repairs to prevent recurrence of the stain. This may require painting of ferrous metals, coating of lead or copper, or diverting water so it does not run across exposed metal onto marble. Deep-seated stains caused by prolonged neglect or from embedded metal anchors may not be removable by any means. Ferrous stains generally appear as red-brown and resemble rust. These result from action of moisture on adjacent or embedded iron or steel. Superficial, fresh ferrous

stains can be removed by vigorous rubbing. Seated stains may be removed with the application of a commercial naval jelly or other rust remover. Stubborn stains may require application of a poultice containing household bleach. Apply for no more than a half hour, then flush at once with a sodium citrate solution and thoroughly rinse with water.

LATEX AND ACRYLIC PAINT STAIN REMOVAL

Latex paints tend to remain on the surface, not penetrating the stone. Use a neutral pH commercial methylene chloride based paint remover, clean water and a stiff bristle brush to remove curdled paint. Rinse the surface with water first.

POULTICES

Properly blended and ready to use poultices and other alternative removal products are available.

REMOVING MILDEW STAINS

Mildew stains from fungus, algae or other living plants are typically black, green, blue orange or blotchy white in color. Rinse the area thoroughly with clean water. Mix a solution of three parts household bleach with one part water and a dash of dishwashing detergent in a spray bottle. Be aware of citric acids in detergents that may cause etching and/or finish damage. Mist the surface until the stain disappears. Rinse surface with clean water and allow to dry. Repeat if necessary.

PRECAUTIONS

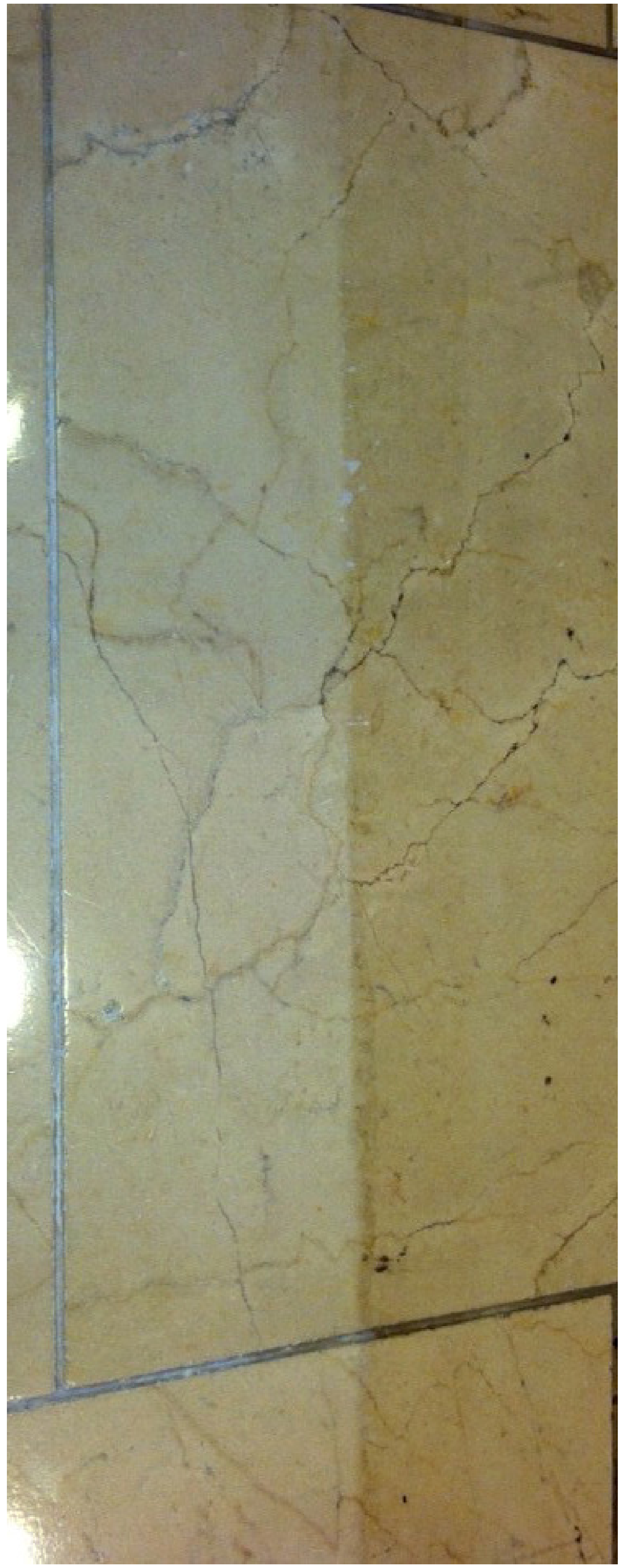
Do not use solvents and waxes/polishes containing color agents, or oils, turpentine, leaded gasoline or kerosene on marble surfaces.

Scouring type cleaners, scouring pads and coarse steel wool should not be used for cleaning polished marble surfaces. The scouring action of these will quickly remove polished surfaces from marble.

Acids or acidic cleaning agents should never be applied to calcareous stones. Acids quickly etch and remove the polished surface. Mild acids, such as citric acid in fruit juices and vinegar, will also etch polished stone surfaces when they are not readily wiped off. Be aware of citric acids in detergent that may cause etching and/or finish damage.

Waxes and finishes requiring high-speed buffers (1,000 to 7,000 rpm) should be avoided on polished stone floors. Most of these materials will not adhere to polished stone until the original polished surface has worn off. Where pieces of stone are lipped higher than adjacent pieces, high-speed buffers may burnish or burn the high corners and edges of marble.

Some chemicals may be harmful to health and environment. Please consult manufacturer's recommendations and carefully read corresponding SDS (Safety Data Sheets). Testing in an inconspicuous area is recommended.



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Mesh-Backed Stone and Tile White Paper

Recently, the tile and stone market has witnessed a proliferation in the offering of larger and thinner surfacing materials and an increased preference for unique varieties of stone, including those displaying heavy veining. As demand for these products has grown, stone manufacturers have reacted by applying fiberglass mesh and/or resin backing to stone tiles and slabs more frequently.

Mesh backing and/or resin has been used for decades to provide reinforcement to both natural stone tiles and slabs. Typically, this backing is fiberglass mesh, and is adhered to the stone with epoxy, polyester or other varieties of resinous adhesives. This backing serves to stabilize the natural stone during production, transportation, and installation. Based on the varied nature of stone, one lot of the same stone may have a fiberglass mesh, while the next lot does not. The decision to apply or not apply a mesh or resin backer is made by the stone producer, and therefore the likelihood of having mesh or resin applied to a given stone type may be greater from one producer than another. There may even be inconsistencies within the same producer's material, with one lot having mesh or resin and a different lot of the same material having no mesh or resin.

There are many common examples of natural stone that often see fiberglass mesh backing applied, including Crema Marfil, Onyx of all varieties as well as other brecciated or heavily veined stones. It is possible, however, to find fiberglass mesh or resin backing on nearly all varieties of stone.

Typically, fiberglass mesh backed stones must be installed with a suitable epoxy setting material. Standard Portland cement based setting materials may not bond with the resinous backing/adhesive, leading to the potential for either immediate or long-term bond failure. Additionally, the high alkalinity of the cement based mortar may have a negative effect on certain backing types, possibly causing bond failure, especially in wet or submerged areas.

Stones with fiberglass and/or resin backing may not be suitable for wet or submerged applications; therefore, it is advised that you work closely with your supplier to determine suitability of a specific material for a particular application.

The *TCNA Handbook* Natural Stone Tile Selection Guide regarding Fiberglass Mesh Reinforced Stone, notes that "Such reinforced stone tiles require epoxy bonding mortar." This includes all reinforced backed stone.

The limitations and/or cautions sections of technical data sheets for Portland cement-based thin set mortars often include written prohibitions against using the product with moisture-sensitive stone or resin-backed tiles or stones. These cautions will frequently direct you to use an epoxy-based adhesive by the same manufacturer.

It has been a common practice in the field to scarify the fiberglass mesh and resin, and install with a Portland cement-based mortar with the hopes that the roughened surface aids in the bond. At the time of this writing, the authors were unable to verify that any manufacturers of Portland cement-based thinset mortars endorse this practice. Increased risk is therefore encountered by the installing contractor, as there is no warranty from the setting material manufacturer.

While a Portland cement-based product that has adequate bond capacity with fiberglass/resin backed stones could likely be formulated, none exist on the market today. Interviews with some manufacturers indicate that the primary concern is the variety of resinous adhesives that may be used on the stone backing, and the inability of the thinset manufacturer to test their product with all adhesives that could potentially be used. These products vary from country to country, and potentially from lot to lot or within lot by the same producer. Performing bond tests with the proposed products is one way to verify performance, but there is still a risk that the stone producer changed types of adhesives during the production of the lot, rendering the initial test results inapplicable.

Improper application of the mesh to the back of tile or stone also represents a challenge. Insufficient quantity of epoxy/resin, or a stone that has not been properly cleaned prior to resin/mesh application, can lead to a bond failure. A thin layer of fine dust, which is quite common in a stone-manufacturing environment, can render the mesh easy to pull off in the field, presenting a weak layer within your installation that can lead to failure. Quality control variables may also exist in the mixing ratios, mixing process, and curing of the adhesive. While insufficient bond between the mesh and the stone seems an obvious fault of the stone supplier, the installing contractor still has an obligation to verify the existence of suitable bond.

There are no industry standards for the application of mesh. Many different alternatives have been introduced to the market over the past several years, including a full fiberglass coating, which based on anecdotal reports, appears to have had a greater risk of bond failure than mesh. Additionally, the use of epoxy/resin with a sand aggregate has been introduced to the market. This sand backing may help to increase the mechanical bond to the setting material, but does not necessarily act to reinforce the stone, which is the ultimate goal of applying the backing. Travertines with epoxy backing, but no mesh, have also been found on the market. As is the case with all stones with epoxy backing, you must determine the suitable setting material before proceeding.

Communication concerning fiberglass mesh or resin backed stones presents a challenge to the industry. The timing of when the contractor is informed of the reinforcement on the stone product is critical. If a contractor learns of the requirements to either use epoxy-based setting material or remove the reinforcement after contracts have been written, the opportunity to adjust the bid price to reflect the increased costs has passed.

When working on a project utilizing natural stone, it is advisable to discuss with the supplier the possibility of the stone arriving with fiberglass mesh or resin backing so proper arrangements can be made. The application should be discussed, and suitability should be determined for areas such as showers, steam showers, submerged and exterior applications. Fiberglass mesh or resin backed stones should not be used in exterior freeze-thaw applications.

Setting material options should then be reviewed. Epoxy mortar is the fall back option, but there is also the possibility of successfully using a primer developed for this application in conjunction with a cementitious mortar. In all cases, it is strongly advised to involve the setting material manufacturer in the discussion early on in the process, and potentially send them stone samples for testing per ASTM C482 and product recommendations.

Fiberglass mesh is also commonly used as a netting for mosaics. Fiberglass is preferable to paper mesh, which should not be used in wet areas. Ideally, the correct amount of adhesive is used to adhere the mesh to the mosaic, facilitating transport and installation, while still allowing setting material contact to the stone or ceramic. If too much adhesive is used, bond to the actual mosaic may be compromised. The smaller the mosaic pieces, the greater the likelihood there is too much adhesive and not enough clean stone or ceramic surface area for bonding mortar. For glass mosaics, request ANSI A137.2 testing which should validate that proper bond can be achieved to the specific finish. It is incumbent upon the installer to verify the proper bond to a mosaic sheet, perhaps by producing a small mock up.

Thin porcelain tiles (6mm or less) have grown in prominence in the marketplace, and in some cases also utilize fiberglass mesh backing. However, manufacturing standards and general characteristics for this man-made product are more consistent and predictable than with natural stone. As with natural stone with fiberglass mesh and/or resin backing, it is advised to consult with the specific product manufacturer for recommendations on usage and installation method, bearing in mind that instructions can vary from product to product.

To increase the likelihood of a successful application, as well as reduce the risk to the installing contractor, it is suggested that this list of best practices is followed when installing fiberglass mesh or resin backed stone or porcelain:

- Discuss the possibility of fiberglass mesh and/or resin backing early in the design and construction process.
- Verify suitability of the stone or porcelain for the particular application.
- Make appropriate setting material choice based on the actual backing and site conditions by involving the setting material manufacturer of choice.
- Ask for written installation instructions from the supplier on any stone or porcelain with epoxy, resin or mesh backing.
- If others supply stone, contractor should add a note to all quotes for cement based mortar installations that pricing is not valid for fiberglass mesh and/or resin backed stones.
- During installation, verify the integrity of the bond between fiberglass mesh and/or resin to the stone by checking a minimum of one piece per box. If adequate bond does not exist, do not proceed with installation until appropriate remedial measures have been prescribed.
- Throughout installation, ensure proper trowel size and techniques are utilized to ensure adequate coverage.

Although the application of fiberglass mesh and/or resin reinforcing has been practiced for quite some time, as its use continues to escalate, the discussion is likely to expand as well. As demand for these types of products increases and the supporting technology continues to grow, further development of industry standards is in the best interest of all concerned. Keep informed of the latest developments via your stone and tile suppliers, setting material manufacturers, industry publications and trade show education. By combining the best practices discussed earlier in this paper and ongoing developments, you have a better chance of avoiding costly installation errors.

Mesh Mounted Mosaics in Wet Areas

The installation of mosaic tile is part of the earliest history of the tile trade. It could be said that mosaics are a part of a modern tile contractor and installer's DNA. However, as modern methods of manufacture and installation have kept this tradition alive, new challenges have arisen that our predecessors never had to conquer, such as mounting systems used to create mosaics sheets. Mosaic sheets are causing new problems for installers. In order to have a successful installation, installers must understand the problem, potential workarounds and recommendations to rectify these issues moving forward.

WATER-SOLUBLE ADHESIVES

Mesh mounted mosaics are predominantly affixed by means of water-soluble adhesives. These come in many types and forms with varying levels of solubility.

There are no industry standards that cover the composition of adhesive, method of application, minimum or maximum thickness of application, amount of backing exposed, or compatibility with dry-set mortars.

Additionally, since many manufacturers import mosaics or outsource the fabrication of their mosaics, tile importers have less control over the end product.

Issues can go unreported, as installers in the field will in many cases just replace failing materials instead of filing a claim with the manufacturer due to the relatively small amount of tile needed and time to completion.

CHALLENGES IN INSTALLATION

The water-soluble adhesives may create several frustrating challenges for the installer in the field, even before they are set into place.

1. Cutting mosaics almost always requires the use of a wet saw. As the mosaic is exposed to water, it could re-emulsify and release the tile from the mesh backing. This can lead to mosaics falling apart on the saw, or in transit from the saw to the installation. With more complex designs, this can cost hours reassembling the design to install, if it's possible at all.
2. There is also the possibility, mainly in horizontal applications or submerged applications that exposure to moisture in the bond coat could also re-emulsify the adhesive leading to the formation of a bond breaking layer between the tile and the mortar. In these critical installations such as a shower floor or a submerged application this could lead to issues well after the installation has been put into service.
3. Excessive amounts of adhesive can be present. Where water-soluble adhesive is exposed to moisture such as submerged applications, steam rooms, or horizontal applications frequently subjected to moisture e.g. shower floors, this can exacerbate the potential for re-emulsification and bond failure. Leaching can occur where the adhesive might re-emulsify and migrate to the surface, creating a stain that is impossible to remove.
4. In installations where UV exposure will be a consideration, the bond strength of the adhesive may be compromised

POTENTIAL JOBSITE SOLUTIONS

Some contractors have resorted to remedies in the field to avoid some of these issues. These may prove to be effective in some respects, but they interfere with installation by adding time and material cost to a project.

1. Liquid or sheet membrane application to the back of the mosaic. This option may avoid the issues associated with cutting and bond breaking on the back of the mosaic. However, it still allows for exposure from the top which may re-emulsify the adhesive and release the tile from mesh backing, leading to failure due to the bond between tile and mesh being compromised.
2. Removal from mesh. Some contractors spend a great amount of time soaking mosaics in water to remove the tile from the mesh backing. While effective, this isn't an option where mosaics have a specific design.
3. Installation with an epoxy setting material. The high bond strength of epoxy may be a good solution in challenging installation environments. Follow the mosaic manufacturers recommendations.

RECOMMENDATIONS

All of these issues add time, cost, and potential for failure to any project where mesh-mounted mosaics are installed. There are other methods and materials that don't have these drawbacks.

1. Edge mounting, also known as dot mounting. This method avoids the potential problems with mesh mounted mosaics as long as the dot mounting material is not water soluble and/or doesn't cover too much of the back of the tile. Care must also be taken with these mosaics to make sure that discoloration of the grout does not occur by having too much of the dot mounting material in the joint causing varying depths of grout and possible discoloration by not leaving adequate depth of joint to fill per the grout manufacturers recommendations. Leaving the back of the tile or stone more uncovered, sufficient coverage is much more attainable. The mounting dot adhesives used in the method may or may not dissolve in water. If they are not water-soluble this can remedy the problem of falling apart when wet cutting.

2. Face mounting. By putting the adhesive mounting system on the face instead of the back, bond breaking layers and coverage are eliminated from consideration. This method may still be difficult to cut with a wet saw for the same reasons outlined above.
   a. Clear film face mounting allows for visibility and more control over placement, however ease of removal depends greatly on type of film and adhesive used. Often, removal of film must wait until the bond coat is set.
   b. Paper face mounting hides the mosaic initially but is easily removed shortly after initial set before the mortar has cured and allows for more adjustability during installation. Applicability of this method may be limited due to material limitations.
3. Non-water-soluble adhesives. There are various alternative adhesives available to manufacturers as options. UV cured adhesives, for example, are not water soluble and while more expensive, might be preferred over water soluble adhesives for horizontal wet or submerged applications. The effect on coverage is not a consideration, as the bond will be unaffected by the adhesive or by water exposure.

CONCLUSION

Mosaic tile will continue to be a fundamental part of the tile trade. It allows for beauty, unique design, and expression. That being the case, if we are to alleviate undue burden to installers in the field it is incumbent on the installer and the specifier/design professional to verify with the mosaic manufacturer, the suitability of the mosaic in wet areas, but especially in horizontal wet areas like shower floors, steam rooms or in submerged applications like pools and fountains. While ANSI A137.1 does not contain a wet bond strength test, ANSI A137.2 and ANSI A137.3 do, and it could be requested of the mosaic manufacturer to run a bond strength test per the criteria in those standards to verify if the exposure to prolonged moisture has the potential to be a problem. Mesh mounted mosaics in non-submerged vertical applications have rarely been seen as problematic due solely to their mesh backing system coming loose or re-emulsifying after installation. Due diligence should be taken, especially with glass or stone mosaics, to verify with the manufacturer the applicability of their products in a desired application, either through testing or documented clarification of applicability.

For glass mosaics, request ANSI A137.2 testing which should validate that proper bond can be achieved to the specific finish. It is incumbent upon the installer to verify the proper bond to a mosaic sheet, perhaps by producing a small mockup.

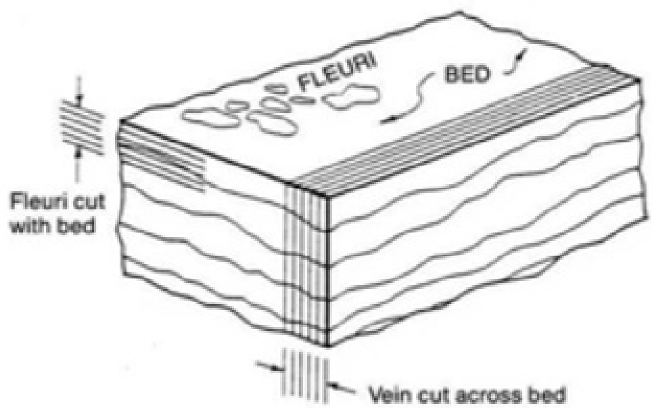
Photo courtesy of NTCA Members Unique Mosaics LLC and Elite-Tile Co.

Repairing Holes on Installed Travertine Tiles

Travertine is a sedimentary stone rich in calcium carbonate and results from chemical precipitation that occurs in or near mineral springs and subterranean environments. Voids in travertine are natural.

Size and frequency of these voids may vary by travertine type and lot. Travertine may either be supplied with these holes filled or unfilled. When filled at the factory, either a cementitious or resin-based fill may be used. Common finishes may be honed, polished or tumbled (typically unfilled).

Vein-cut travertine is cut against the bedding planes, exposing the edge of the formation and providing linear pattern. Fleuri-cut travertine, also called cross-cut travertine, is cut parallel to the bedding plane, exposing a flowery random pattern.



Holes may open up as a result of normal use due to thin wall cavities at or near the exposed surface of the stone. In some cases, factory fill may pop out as a result of use and wear.

Repairs of holes in travertine are common. The first step is to identify the type of fill that is currently in place. Holes may be filled with cement, epoxy, and/or grout to match the existing color and finish of the fill.

Professional stone restoration firms may be available in your area and should be members of the National Tile Contractors Association and/or the Natural Stone Institute.

Additional articles on this topic are listed below:

- How to fill Holes, Cracks and Voids in Travertine Tiles by Troy Cantini
  https://www.tilecleaning.org/filling-holes-in-travertine-tile.htm
- Travertine by Excel Stone and Tile Care
  https://excelstoneandtilecare.com/travertine/

Six-Sided Sealing: Its Role in a Water Management System for Natural Stone and Tile

THE PROBLEM – MOISTURE

Natural stone today is as popular as ever among customers who value its beauty, durability and uniqueness. The unique inherent qualities of natural stone can pose challenges when installing stone (and certain natural clay or cement tiles) for interior and exterior residential and commercial applications. Many installations suffer from problems such as picture framing, soluble mineral blooms and staining (for example from soluble pyrite, iron sulphide), water marking including picture framing, and even primary and some secondary efflorescence are well known to experienced members who work in the stone industry. (Photos 1 and 2) In other cases, the base of stone veneer and seat walls may be stained from moisture wicking up, bringing impurities that permanently discolor the installation. (Photo 3) Although not all natural stone and tile are prone to moisture issues, commonly used marbles, limestones and granites, terracotta and cement tile among others are prone to moisture issues. Therefore, the question of how to prevent moisture issues with sealing all six sides of the material, instead of the top surface only, is more relevant than ever.

Photo 1: Picture framing on granite

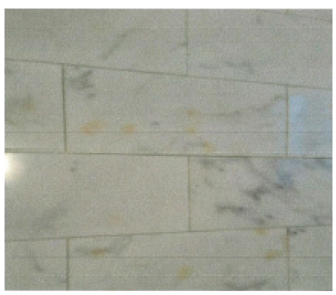


Photo 2: Iron staining on marble

Photo 3: Moisture wicking of impurities

The pH and quantity of water are critical factors in determining the potential risk for staining, and – most importantly – the degree of staining. The greater the quantity of water and the higher the pH (more alkaline), the greater the risk and degree of staining. Moisture staining in certain types of limestones is common along with other stones. (Photo 4) Stones are most at risk for moisture staining during the installation phase. During installation, there are both significant quantities of water available from the adhesives/mortar, and high alkalinity due to the majority of adhesives/mortar being Portland cement-based. So in short, managing the amount of water that can be absorbed by the material during the important installation phase, as well as managing the water post installation, is the best way to reduce the risk of moisture types of stains occurring.

Preventing water from being absorbed into the material during the installation and resultant cure of the mortar and grout is critical. Other sources of moisture can have an equally damaging effect. Moisture in a concrete slab can migrate through capillary action into the assembly and cause damage. Environmental exposure to weather conditions, interior wet areas, accidental spills and joint fillers are other causes of irreversible staining.

Photo 4: Alkalinity staining on limestone

HOW CAN YOU KNOW IF SIX-SIDED SEALING WILL HELP?

Often, certain stones are known to have potential risks, such as white Carrara marble with iron staining. In some cases, previous experience with a stone history is valuable. The stone quarrier, importer or supplier may caution about such potential issues prior to installation. If the stone history is not provided, asking for any data and testing can produce useful information. But given the amount of natural stones we see today (as well as some non-porcelain products such as encaustic cement tile), and with new natural stones being discovered frequently, there is no substitute for a mock-up to assess and ensure that all variables and risks have been addressed up front when all other avenues fail. (Photo 5)

Photo 5: Mock-up test showing sealed stones vs. an untreated piece

A NEW APPROACH: SIX-SIDED SEALING

Due to the potential problems of moisture, some believe there is no alternative but to not use, sell or specify certain stones that may pose a challenge. The good news is, there is another approach that can be implemented to aid in the management of water, thus allowing natural stones to be successfully installed. By sealing all six sides of the stone or tile, water is prevented from entering and moving through the material to the surface, thereby potentially triggering one or more of the potential moisture issues outlined. With the right sealer, potential damage from moisture exposure and capillary migration will be reduced and possibly eliminated. Six-sided sealing is an important component (not the sole solution) in creating a successful water management system for these installations.

Managing the amount of water that can be absorbed by the stone or tile during and after installation is the best way to reduce the risk of moisture problems from occurring. However for a sealer to work successfully in this environment, the sealer must have two important characteristics. The first is the sealer does not interfere with the bond of the adhesive. The second is the sealer can perform in the high-alkaline environment of the curing cement adhesive or mortar. For many years in the industry, sealers have been seen as either bond breakers or products that significantly reduce the effectiveness of an adhesive. Therefore sealers have not been recommended or advocated for the use of sealing the back and sides of stone and tile. The tile and stone industry has acknowledged the potential ability of sealers to reduce the risk of staining during installation.

While not commonly used in North America, six-sided sealing has been recognized and used successfully around the world from Europe to Asia to the Middle East for decades. Six-sided sealing has been experienced by many companies and industry professionals around the world. Manufacturers that use the highest quality raw materials and latest chemistry advancements have produced sealers that are not bond breakers and can perform effectively in a high-alkaline environment, making the sealer suitable for application to all six sides of a stone or tile. As most sealers are not suitable for the six-sided sealing process, the chemistry of the sealer is critical to ensure successful results. The right chemistry not only allows for proper performance in a high-alkaline, wet environment, but due to the sealer residing within the stone or tile and not on the surface per se, six-sided sealing ensures the ability not to interfere with the bond of an adhesive, cement mortar or grout. Two questions often asked are: Does the six-sided sealer still allow for the adhesive to cure and stone to breathe? The answer is yes for both.

With regard to application, first any dust or residue should be brushed off all sides of the stone or tile material. Since fabricating stone tiles or pavers is a wet process, elevated moisture readings may occur when natural stones are immediately removed from the crates, boxes or packing containers. For best results, allow the moisture to dry out prior to sealing. Use a moisture meter prior to sealing to verify the present moisture content, and discuss with the sealer manufacturer and other parties to the project to determine the best course of action if elevated moisture levels are detected.

There are several ways to apply the sealer to all six sides, such as brushes or paint rollers, but the most effective and efficient method is to submerge the stone or tile in the sealer and allow for full absorption into the stone or tile. The stone or tile should be submerged on average for 10 to 15 seconds to achieve maximum penetration, but the time may vary by stone. After being removed from the sealer bath, the tile or stone must be must be wiped dry of any excess sealer on the surface. In some cases a squeegee can be used to remove any excess sealer. Again, testing is always recommended as the type and texture of the stone or tile, jobsite conditions, and variables along with the experience of the person(s) applying the sealer will vary.

The sealed tiles should be set up on narrow supports so that air can get to all sides, and allowed to dry thoroughly. (Photo 6) The sealer must completely dry on the tile or stone before installing with cement-based mortars. After sealing, test tile or stone samples to ensure that water beads on all six sides. The cure time and process will vary based on product used and conditions outlined above.

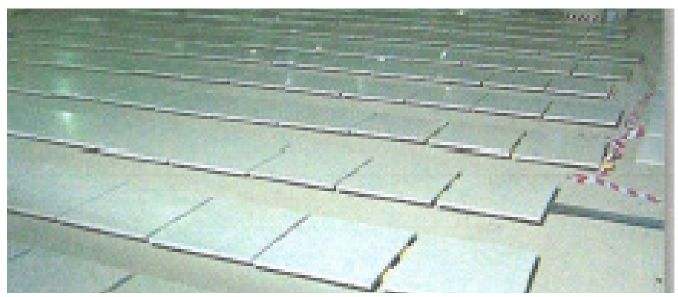


Photo 6: Ensuring tiles are staged for proper sealing and cure.

DOES SIX-SIDED SEALING MANAGE THESE PROBLEMS BY ITSELF?

Since sealers do reduce and slow down water absorption (but ultimately do not stop water totally because the sealers are not waterproofing materials), the sealers are a critical component of a full water management system, but are not the complete answer in-and-of themselves. A full water management system should be considered and the appropriate components implemented across the entire assembly to fully protect the installation from the staining and contamination. Six-sided sealing systems will have other benefits in terms of helping to reduce the risk of other water related problems such as freeze/thaw damage and dimensional deformation (warping), a well-documented problem with water-sensitive stone.

So what are the main components of a water management system? There are a number of elements to this system that should be considered when designing, specifying, selling or installing. The main components are as follows:

1. Correct falls – making sure residual water can exit via properly installed drains is imperative to the success of an instal-

Photo courtesy of Crossville

lation exposed to water. Water that is allowed to pond or stand will increase the risk of water-related staining as well as moisture issues such as freeze/thaw damage, efflorescence and warping of moisture-sensitive stone.

2. Waterproof membranes, primers or water remediation systems-keeping the substrate underneath the stone/tile as dry as possible is an important part of a successful problem-free installation. Water can be sourced both externally and internally. Internal water can come from ground water (exterior on-grade installations) and external from weather that can filter through the installation to be stored in the substrate. So the application of products to address possible ground water (epoxy water remediation systems) or waterproof membranes to ensure the substrate cannot store water supplied from above will greatly reduce contamination issues as well as reduce freeze/thaw and dimensional deformation.
3. Use of appropriate adhesives - using appropriate specialized polymer-modified mortars, rather than conventional mortars, will help to reduce water in the system. In the case of water-sensitive stone using an adhesive that contains no water at all (100% solid epoxy) may be required. When a sealer is applied to the back of a stone or tile, the sealer reduces the surface water absorption close to zero. The sealed surface effectively acts more like a very dense material. Therefore adhesives that are recommended for dense materials such as granite or porcelain tile should be used along with their specific installation methods even if the stone or tile is a naturally less dense material such as limestone, sandstone or similar stone. In some cases, using a rapid-set mortar may be beneficial.
4. Proper placement and use of sealants – movement expansion joints are important because the movement expansion joints manage the natural expansion and contraction of the installation. If movement expansion joints are not properly installed, the lack of movement expansion joints can lead to the loss of adhesive bond to the tile or stone. Initially one of the consequences of lack of movement expansion joints is that voids are created under the stone/tile and can collect water resulting in staining and contamination problems. If joint placement is left unresolved the movement expansion joint can ultimately lead to the complete failure of the tile or stone installation.
5. Six-Sided Sealing – As discussed in this document.

In summary, keeping a stone or tile installation as dry as possible, both during installation and after, is the key to minimizing water-related problems. The use of six-sided sealing is most beneficial when used during the installation and curing phase of the adhesive/mortar (approximately 28 days) where the risk of moisture issues is highest. The six-sided sealing process must be seen as one component in a complete water management system. Implementation of the complete system is required to properly manage all risks of moisture types of stains that can occur during installation and to a lesser extent throughout the life of the stone or tile installation.

Six-sided sealing will prove helpful in solving many of the challenges of certain tile and stone installations. Six-sided sealing is not a guarantee. Since no two stones are the same, and no two jobs are equal in all variables and aspects, six-sided sealing process must be tested and vetted to ensure that six-sided sealing will provide the desired outcome prior to full scale use.

ADDITIONAL BENEFITS OF SEALING

When the face of the tile has been pre-sealed, grouting becomes a faster and easier process. The sealer will prevent the grout from potentially staining the face of an otherwise porous tile. Sealing stone or tiles makes the process of removing the grout from the face of the tile during installation easier. Pre-sealed material is similar to using a grout release product. Since all sides of the tile have been sealed, water will not migrate into the stone and darken the stone. Six-sided sealing will prevent dyes in grout and silicone sealant from entering the tile and creating “picture framing” around the perimeter.

Because the tiles are pre-sealed, the tiles are protected from accidental spills during the first few days after installation. Normally the installer or owner must wait several days for the grout to cure before sealing the entire installation. During the curing period, the tiles are typically unprotected, but pre-sealing the stone or tiles eliminates the concern of accidental spills affecting the finished installation.

Over time, the repellent qualities of the sealer will be affected by the hardness and texture of the material, surface wear, weather conditions and cleaning regimens. All installations should be periodically tested, at least annually, to ensure that the sealer is still doing its job.

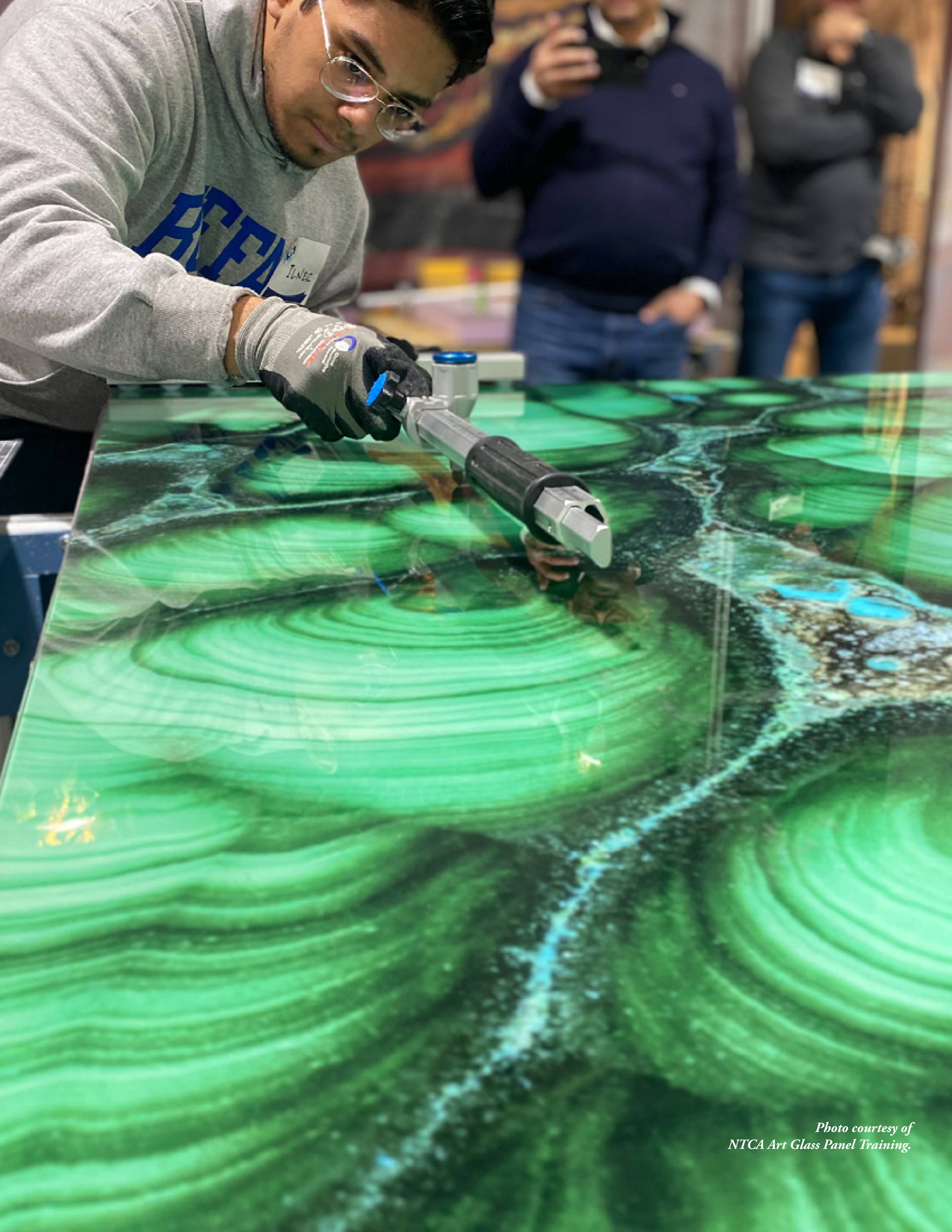


Photo courtesy of
NTCA Art Glass Panel Training.

Glass Tile Description

Glass tile is a tile having a 100% non-microcrystalline (no clay) body manufactured generally in one of the three following processes.

Hot-Molten – (cast) glass tile is generally manufactured above 1500°F using various base materials such as silica sand and recycled glasses from post consumer bottles and jars, collected civically and/or post industrial glass collected from commercial businesses. Using recycled glass dramatically reduces the amount of refuge taken to landfills.

Warm – (fused, including sintered) glass tiles are typically produced from commercially manufactured flow (window type) glass altered through heat between 1000°F - 1499°F. Heat at and above this range facilitates a fusion between the paints, foils, metals, glass frits and other materials to the glass tile's body.

Cold (cool) – This type of glass tile may also wear additional glass, paints, foils and other decorative products, however, they do not normally have the same performance qualities as "hot" or "warm" glass tile due to low, 500°F or less, manufacturing temperatures, which do not allow the decorative materials to fuse to the glass tile's body.

CAUTION

Cold applied glass tile may not be appropriate for use in wet areas such as showers, tub splashes (with showerheads), steam showers, pools and fountains. Cutting may also prove challenging as cold applications may be damaged during cutting, drilling and installation. Check the manufacturer's written specifications to confirm intended uses and installation materials and procedures prior to commencing work.

With so many glass tiles on the market care must be taken when specifying and installing these products. Installers are advised to research glass tile manufacturers recommendations for substrate preparation as well as installation materials and techniques for installing all glass tile products.

If no or insufficient manufacturer recommendations exist, an architect or other design professional shall specify the appropriate substrate preparation methods from the current year *TCNA Handbook*. Additionally, an architect or design professional shall specify all installation and movement joint types, materials and locations to be used by the tile contractor/installer.

As with all net-backed tile, the manufacturers of net-backed glass tile products shall verify, in writing, the recommended use of all net backed glass tile for use in all wet areas.

NTCA general substrate preparation methods recommended for glass tile are published in the *TCNA Handbook*. These procedures are general in nature as some installations may require more specific in-depth information. Consult an architect for more detailed information on substrate preparation.

The performance of a properly installed thin-set tile application is dependent upon the durability and dimensional stability of the substrate to which it is bonded. The following recommendations are from the *TCNA Handbook* and are general in nature.

FLOORS

1. Exterior: Concrete slab cured 28 days minimum, follow TCNA F102-14 (recommended for freeze/thaw areas).
2. Interior: Concrete TCNA F111-14, F112-14 or F113-14. Additional preparation may be necessary depending upon its condition. Cement mortar beds should be cured a minimum of 7 days.
3. Interior Wood Sub-Floors: Cement mortar TCNA F145-14 or cement backer board (CBU) TCNA F144-14.

WALLS

1. Exterior and Interior: (masonry or concrete) TCNA W201-14, W202-14, W211-14 or W231-14
2. Interior Metal Studs: TCNA W241-14 (must meet ASTM C955 or ASTM C645) or cementitious board units over wood or metal stud*
   (CBU) TCNA W244-14
3. Wood or Metal Studs: under gypsum board in dry areas only TCNA W243-14

SPECIALTY

1. Bathtub Walls: (wood or metal studs, cement mortar beds cured 7 days) TCNA B411-14 or (CBU) TCNA B412-14
2. Shower Receptors, Walls: (wood or metal studs, cement mortar beds cured 7 days) TCNA B414-14 or (CBU) TCNA B415-14
3. Countertops: (cement mortar beds cured 7 days) TCNA C511-14 or (CBU) C513-14
4. Swimming Pools: (cement mortar beds cured 7 days) TCNA P601-14

**Membrane (ANSI A.2.1.8) of #15 roofing felt or 4-6-mil polyethylene film is required behind CBU. All joints on CBU should be taped with the CBU manufacturer's recommended mesh tape and allowed to cure 24-48 hours prior to installation.*

MEMBRANES

The use of membranes may be beneficial to some glass tile while not advisable for other glass tiles in all installations (refer to manufacturer's instructions).

An example of problems arising from improper membrane use with glass tile is using it between the setting material and setting surfaces such as cement board or mortar beds in wet areas for the installation of transparent (glass tile you can see through) or light translucent glass tile (glass tile you can see light through).

When installing transparent and light translucent glass tile, membranes shall be applied between the sub-structure (framing) and substrate (mortar bed or cement board).

If membranes must be used topically (on the face of substrates) in wet areas, transparent and light translucent glass tile should not be installed.

Photo courtesy of Casalgrande Padena

Glass Tile

PROBLEM CHARACTERISTICS

Notch trowel marks or lines visible behind glass.

Shade variations (ghosting) visibly lighter in color than the rest of the setting bed behind the tile.

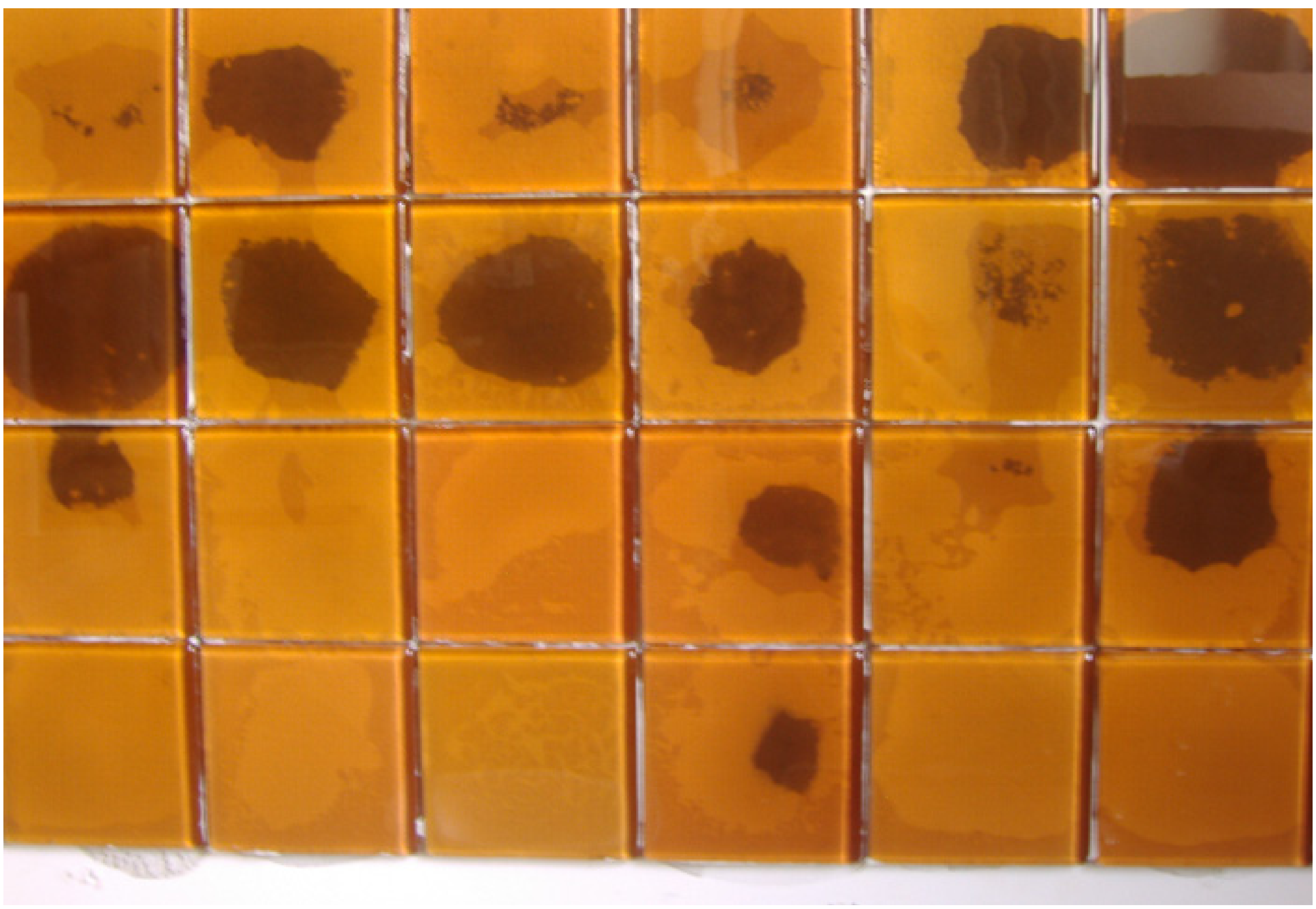
Loss of bond.

Cracking.

WARNING:

Due to differences in glass tile products, some glass tile manufacturers preclude the use of a waterproof/crack-isolation membrane with the installation of their glass tile; some manufacturers recommend the use of a waterproof/crack-isolation membrane; some manufacturers preclude the use of epoxy setting and/or grouting materials when installing their glass tile; some manufacturers recommend the use of epoxy materials. **Check with the glass tile manufacturer for their product-specific recommendations. Make sure to get the glass tile manufacturer's installation instructions in writing. Make sure they warrant the consequences caused by lack of proper waterproofing in wet areas. Reading and understanding the glass tile manufacturer's installation instructions before the installation takes place is important for the performance of the glass tile.**

REFER TO THE *TCNA HANDBOOK*: PRODUCTS WITH SPECIAL INSTALLATION GUIDELINES/GLASS TILE.



The wrong adhesive was used in this glass installation. Always check with the glass tile manufacturer for their product-specific recommendations.

Photo courtesy of Cox Tile, Inc., NTCA Five-Star Project of the Year Artisan Grand Prize winner.

SAMPLE LETTER FOR TILE CONTRACTOR

Date

Company
Address
City, State Zip

Re: Project

Contact:

Glass tiles have been specified for the above referenced project. There are three different types of glass tiles: cast glass, fused glass, and low temperature coated glass. Furthermore, glass tiles are divided into three size categories: large format (approx. 3”x3” and larger), mosaic (approx. between 3”x3” and 3/4”x3/4”), and miniature mosaic (approx. smaller than 3/4”x3/4”). Different glass tile types and sizes have varying performance and aesthetic requirements that are defined by ANSI A137.2 American National Standard Specifications for Glass Tile.

The individual tiles for all types and size categories may be free standing or are mounted together to create assemblies or sheets of tile that allow for more efficient installation. Glass tiles that are mounted can be done so in one of several different ways such as removable paper facing, edge mounting or back mounting.

Different glass mosaic tile types and sizes, and the different mounting methods that might be employed, can have an impact on varying levels of performance and aesthetics. Additionally, for example, some may be suitable for wet areas such as pools or spas and others may not.

The service environment for the glass tiles may also require specific installation instructions and materials.

To help ensure a successful installation, the following must be provided to us by the glass tile distributor or manufacturer:

- Glass tile performance test results for the statement of intended use, conformance to ANSI A137.2, and relevant glass tile type (cast, fused, low temperature-coated) and size category (large format, mosaic, miniature mosaic)
- Substrate requirements
- Detailed installation instructions
- Waterproofing and crack-isolation membrane recommendations
- Setting material and grout recommendations
- Expansion joint requirements

The timely provision of this information to us is greatly appreciated.

Name and Title
Company

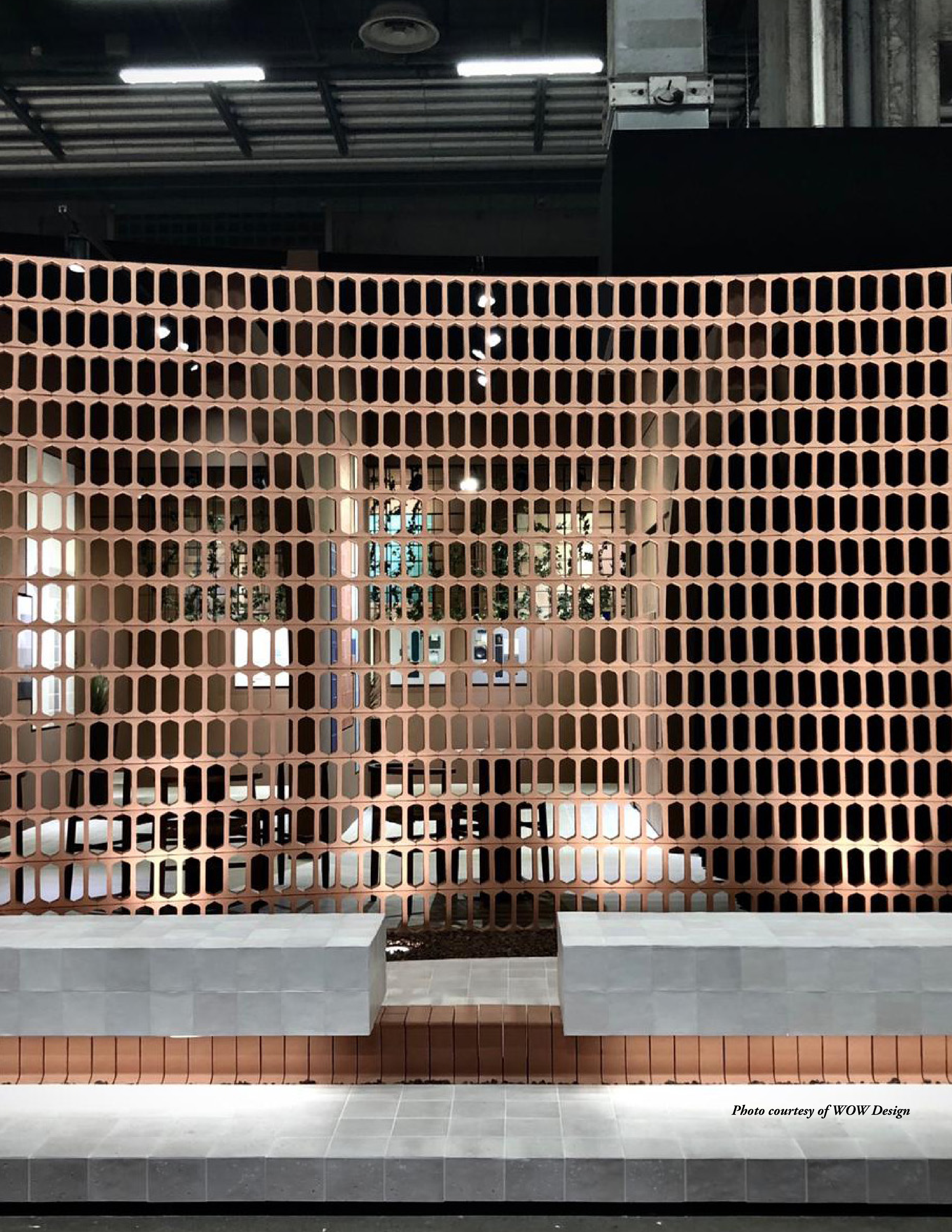


Photo courtesy of WOW Design

Pressed Cement Tile

What is pressed cement tile? Pressed cement tiles are handcrafted one by one and hydraulically pressed. Unlike other cement tiles, these tiles are not fired. They are made of layers of fine ground Portland cement and coarser sand mixed with cement. The pigment layer is hydraulically pressed into the surface and becomes a part of the tile. It is speculated that these tiles were first manufactured in the 1850's in Spain. The trade names of the tiles have a variety of names such as: Cement Tile, Redondo Tile, Mission Tile, and other privately labeled names.

Pressed cement tiles are manufactured in the United States, Spain, France, Italy, North Africa, Latin America, Indochina, Vietnam, and Mexico.

Note: There is a marketing strategy that labels encaustic tiles to be the same as cement tiles, but they do not meet the same definition. **This section is for Pressed Cement Tile Only**

CONTRACTOR CONSIDERATIONS WHEN INSTALLING PRESSED CERAMIC TILE
Although they have been installed successfully for over 150 years, there are challenges with installing these types of tiles. Here are some considerations/questions that may arise during when pressed cement tile is installed..

Thickness variations of pressed cement tile create challenges installing them. The traditional method, prior to the invention of thin-bed adhesive mortars, utilized a mortar bed and the beating of the tile into fresh mud using a bond coat of neat cement. This method allowed for the installation of the pressed cement tiles of varying thickness to have no apparent variation (lippage) in the finished surface. With the development of thin-bed adhesive mortars, the ability to install tile of different thicknesses was lost because the adhesive mortar bond coat is only 3/32" to 1/8". LFT/LHT adhesive mortars which allow for bond coats thicknesses from 3/32" up to 3/4" to help, to achieve flat finish installations of pressed cement tiles that have variations. Use of adhesives that allow for thicker bond coats can make it possible to achieve installation that meet the required finish flatness and lippage requirements outlined in ANSI A108.02-4.3.7 and the *TCNA Handbook*.

To achieve an acceptable installation, the installer must account for variations in the tile thickness and size. Do a mockup to manage customer expectations and show the irregularities that are inherent with this type of tile. Non-sag tile mortars for large and heavy tiles allow for a thicker bond coat to account for different thicknesses while supporting the weight of the tile. Lippage control devices can be used as an aid to help with the different thicknesses of adjacent tiles, although they are not recommended due to possibility of chipped tile edges when removing their bases or stems. A skilled, experienced craftsperson is recommended to flat finished installation with tiles manufactured in different thicknesses and without exceeding maximum bond coat requirements.

Joint Size
Customers sometimes ask to butt joint the tiles. **This is not advised!** ANSI A108.02-4.3.8 Grout Joint Size states that your grout joint width should be not less than three times the size variation of the tiles being installed. It is particularly important to follow the manufacturer's instructions to install their product properly because pressed cement tiles do not meet ANSI A137.1 standards.

Fading or discoloration
Direct sunlight may cause the tiles to fade or discolor over time. Heavy foot traffic can also alter the appearance of the tile over time.

Porosity of pressed cement tile can create issues
Porosity is a challenge with pressed cement tiles because they are not fired in a kiln. Some of these tiles will even have a high content of moisture after shipping from the factory. ***Check the tiles with a moisture meter for excess moisture before installation***.

If pressed cement tile is installed and not allowed to dry sufficiently, curling can occur. Additionally, when placed over impervious membranes, moisture exposure is increased and extended which can result in warpage.

Grouting concerns
Most manufacturers recommend pressed cement tile be sealed with multiple coats of a specifically recommended sealer before grouting to minimize or eliminate staining from the grout. Topical sealers, penetrating sealers, and grout releases are used to minimize staining. Most manufacturer's recommend high-performance and/or urethane grouts to minimize staining.

Mockups
It is strongly advised to do a sample mockup of the tile assembly with several loose pieces before starting the actual installation . Testing mortar and grout on these tiles will set end user/owner expectations and can point out any issues to be resolved prior to the actual installation.

Again, following the manufacturer instructions is necessary for success. If tiles become stained, it may be impossible to remove the staining. **NEVER DRY SAND PRESSED CEMENT TILE!** Dry sanding could scratch the surface. There has been some success with wet sanding the surface of the tiles to remove stains when necessary. Use silicon carbide 200 grit sandpaper to refinish the face. If you use higher grit sandpaper (for example 320, 400 or 600 grit) it will enhance the shine on the tile area in question. Enhanced shine may not match the unfinished tiles.

Always test before doing the entire floor!

Cracking

Substrate preparation is important. Pressed cement tiles are prone to cracking if the substrate is not prepared properly or if there is differential movement of the substrate. Use caution when handling pressed cement tiles. The edges are fragile and can be chipped if not managed with care.

What is the recommended setting/grouting products to use with these?

Since pressed cement tile does not meet ANSI standards, installers must read and follow the manufacturer's installation instructions on setting and grouting. If none are available, ask the distributor, the installation material manufacturers, and other reputable contractors what they have done for a similar successful installation. Use a premium large and heavy tile mortar with non-sagging properties. A premium grout will help with staining or preventing it. A mockup is strongly encouraged to try to avoid any potential issues when the installation takes place.

Does grout stick more readily to the surface of cement tiles and how do you avoid this?

Pre-Seal or Grout Release

Conduct a simple water drop test on the face of the tile to help determine the porosity level.

Most pressed cement tiles have high absorption rates which may require pre-sealing with multiple coats of a quality sealer. Typically, the sealer would be applied until the water beads up on the surface or absorbs very slowly into the tile. Pre-sealing should be performed as part of the mockup and will help set customer expectation levels. Contractors should build this step into their price for labor and materials. Never leave a grout haze on the face of the tile. These tiles are sensitive to acid and it should be avoided at all costs if the tiles are not cleaned correctly. Consider a urethane grout in lieu of a traditional cementitious grouts which contain pigments that could immerse the color in the microscopic pores of the tile body and prove very difficult if not impossible to remove.

Detailed, Textured Surfaces

Some pressed cement tiles are incredibly detailed and have up to eight assorted colors and a multiple number of patterns. The texture may differ from manufacturer to manufacturer. Sealing or grout release prior to installation is paramount to the success of the installation. A mock-up will help alleviate issues during the installation.

What other challenges do these products pose to installers?

Customers' expectations are always the main concern. Each job presents its own issues for the installer. Following manufacturer installation instructions and guidelines is necessary for a successful install. Consultation with the mortar and grout manufacturers is also highly recommended. Check the moisture content of the pressed cement tile after obtaining the shipment. **Do a mock-up of the tile installation along with sealers, and grout choices. When all instructions are followed correctly, there is a much lower chance for a failed installation and a much higher chance of meeting the customer's expectations.**

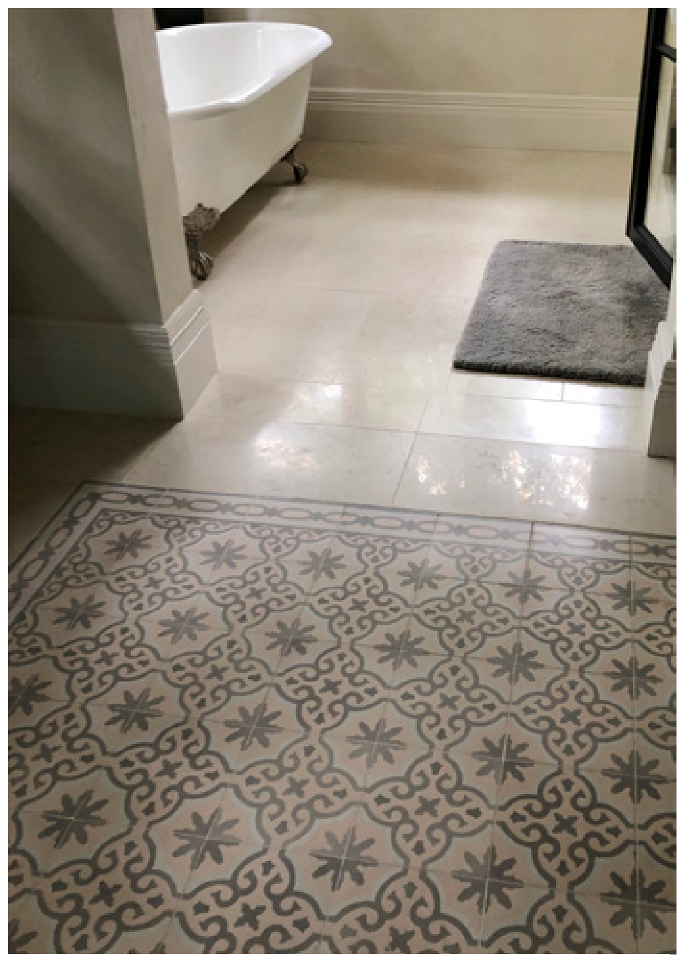


Photo courtesy of Cox Tile

Pressed Cement Tile

Problem	Cause	Cure
Thickness variation from tile to tile	Each tile is manufactured one piece at a time. You can anticipate thickness variation as normal.	Visually inspecting and shuffling tiles to get a blend. Dry lay tiles as a mockup before installing. Use the proper mortar for installation. Use a non-sag mortar. There will need to be some adjustments during the installation due to thickness variation of the tiles. Use a qualified contractor or installer that is familiar with these types of tile. Follow manufacturer installation instructions.
Tiles chipped or cracked	Poor handling or packaging	Visually inspect tiles when unpacking. Notify supplier immediately upon receiving damaged material. Do not install before discussion with supplier for new product.
Wet tiles in boxes	May have excess moisture trapped in boxes from packaging and/or/shipping	Excess moisture will migrate back through the tile surface. Remove tiles from boxes and air dry before installing. May need to perform a simple moisture test with visqueen.
Thickness variation from tile to tile	Each tile is manufactured one piece at a time. You can anticipate thickness variation as normal.	Visually inspecting and shuffling tiles to get a blend. Dry lay tiles as a mockup before installing. Use the proper mortar for installation. Use a non-sag mortar. There will need to be some adjustments during the installation due to thickness variation of the tiles. Use a qualified contractor or installer that is familiar with these types of tile. Follow manufacturer installation instructions.
Stains on surface from mortar and grout residue	Not pre-sealing tile or using a grout release before grouting. Not properly cleaning the surface from setting mortar or grout. Cementious grouts have Portland cement and may contain color pigments that can migrate into the microscopic pores and can prove to be very difficult or impossible to remove.	Some manufacturers have cleaning products to aid and possibly remove stains. It may require several steps or products to achieve desired results. One method may be to lightly wet sand the tiles. You can use multiple grits to achieve the results you are seeking. Follow manufacturers instructions when using urethane or hybrid grouts. Grout small sections at a time and cleanup before moving to the next section. This process is more tedious and time consuming. Allow proper time and do not get over anxious during the process.

Problem	Cause	Cure
Tape residue on surface of tiles after installation	This is generally done to secure construction paper, cardboard or other protection materials during construction.	Overlap construction protection and do not tape to the surface of the tile. Ensure the installation materials have had adequate time to dry before covering. Cover with a breathable material, NOT VISQUEEN. Some manufacturers have products to aid in the removal of the residue. It is advisable to duplicate the conditions on extra pieces. It may require several steps and products to achieve satisfied results. It may require wet sanding as discussed above.

Pressed Cement Tile Maintenance Issues

Etched, stained, scratched, diacolored, excessive wear patterns in tiled areas	Improper use of acidic cleaners. Improper use or lack of maintenance products. Direct sunlight.	**DO NOT** use acidic cleaners. Identify high traffic areas. Use floor mats for protection. Consult with manufacturer on proper products to protect and maintain the integrity of the installation. Some maintenance products may not be recommended for direct sunlight applications and could break down when exposed to UV light.

Photo courtesy of Cox Tile

Handmade Tile Installation

Handmade tiles have been available for centuries and come in many sizes, thicknesses, and shapes. Because each handmade tile is unique, the installation of these tiles requires special attention to provide a finished project that will be acceptable to the consumer.

Given the unique nature of handmade tiles and the fact that they may not meet any of the ANSI A137.1 standards, several questions must be addressed prior to installation.

- Is the location suitable for the tile?
- Will it be used on an interior or exterior substrate?
- Is the tile recommended by the manufacturer for dry and/or wet environments?
- Can it be placed in a submerged situation or in freeze/thaw climates?
- Will the tile be appropriate for walls and floors?

The answers to these questions must come from the handmade tile manufacturer that should know of any limitations or cautions on usage. Installing these tiles without answers to these questions or proper written installation directions and recommendations can be a recipe for a very costly failure which may be solely borne by the installer. Be aware that just because the tile is available for sale doesn't mean that it is applicable for every job. If the tile manufacturer cannot or will not provide detailed guidance on the installation process, it may be wise to walk away.

EDUCATE YOUR CLIENT

Do your homework well in advance of the start of the project. The unsuspecting consumer may be enamored with their selection, but they may not know if the selected tile is suitable for his/her project. The best way to proceed is to educate the consumer on the characteristics and idiosyncrasies of handmade tile and the critical points of a successful installation. Providing information about handmade tile's unique nature as to significant size and shape variations, small glaze fissures or cracks, widely varying glaze color and shading, as well as the potential of bowing, twisting, and warping is extremely important. Some clients love the imperfections of handmade tile and are willing to accept them, while others find the inherent variations unacceptable and will reject them.

USE A MOCKUP

The best way to achieve success is to work with a client who has realistic expectations. Helping the consumer understand how the finished product will look before the installation begins is realized by the use of a mockup which is strongly recommended. The mockup may be as simple as dry laying the tiles on a flat surface using the selected pattern and grout joint size or an actual installation complete with grout and sealant joints. The choice of grout color can be problematic and must be examined. The use of a grout color that strongly contrasts the tile color will show in the fissures, pits, and irregularity of the tile and will be difficult or impossible to remove.

If the tile size varies greatly, some of the tiles may touch each other (no grout joint) while others have extremely wide joints. Although handmade tile normally doesn't meet the ANSI A137.1 requirements of ceramic tile for sizing, the grout joint suggestion could be helpful, taking the size variation between the smallest and largest tile and multiplying that size difference by a factor of three. As an example, if the tile size varies by 1/8", multiply 1/8" times three. The recommended grout joint would be 3/8". Another way to look at determining the grout joint width is looking at how the tiles are aligned. With handmade tiles it is necessary to space the tiles by aligning the centers of the tiles instead of aligning the edges of the tiles as you would with rectified tiles. This is how rows and columns stay consistent.

At this point, the decision must be made on what grout joint size that will be acceptable to the consumer, but most importantly, will this joint size accommodate the variation in tile size? The use of wide grout joints may not be acceptable to the client, but that may be the only way the tile can be effectively installed. Additionally, the mockup will exhibit the full range of color variation, glaze texture, surface defects or imperfections, crazing (hairline cracks), and tile warpage. When the mockup is acceptable to the client, have them sign and date it. The mockup should be retained by the installer until the completion of the project to be certain the client(s) doesn't suffer from selective amnesia once the project is complete.

With an approved mockup at hand, the following techniques and tips may be helpful in satisfying the customer's expectations.

Techniques and Tips for a Good Handmade Tile Installation

- Follow the tile and mortar manufacturer's recommendations to the letter.
- Sealing the tile prior to installation is an excellent practice. Doing so will help with cleanup of the tile after installation. It also prevents mortar and grout from lodging in glaze crazing or fissures.
- Many times, these tiles are boxed directly from the kiln without blending the inherent color variations. Prior to installation, blend tiles from multiple boxes for a more even distribution of color. Skipping this critical step may result in "blocks" of colors on the wall which may not be acceptable.
- While blending the boxes, check for any obvious defects or imperfections which should be set aside.
- The unique nature of handmade tile will require additional time to install. To extend the open time of the improved dry-set cement mortar, apply a liquid-applied or sheet membrane to the substrate to slow the initial set time which allows more time to make adjustments to the tile.
- Some tiles, such as Zellige, may require soaking in water prior to installation. Always check with and follow the manufacturer's recommendations.
- Using a mortar with a longer open time is helpful for making alignment adjustments.
- Instead of leveling every course, try leveling 2-3 courses at a time as that allows for tile size variation. This process will allow adjustments to be made in the installation as needed.
- Using wedge or roto-wedge type spacers can be helpful as they have the flexibility to accommodate size variation.
- Rather than using plastic spacers, try using string or nylon rope in different thicknesses to space the tiles. Use either a woven or braided string/rope. NOTE: Do not use twisted twine, sisal, or jute as these materials have fibers that will remain in mortar after the string is removed from the joints, which can be tedious to clean up. Also, do not use this method on tiles that are hand chiseled where the tile body is beveled toward the back of the tile such as Zellige tiles. Dip the string/rope in water prior to placing it on top of a tile course, add the next 2 or 3 courses of tile using string/rope between each course. Using a straight edge or level, gently compress the tile to level the tile courses. The string will compress with a larger tile but will not compress under the smaller tile. The string/rope can be removed the next day. One advantage of using string /rope is that when pulled out, the grout joints are clean and free of mortar.
- To prevent chipping crackle glazes when cutting, using a glass saw blade may help.
- When installing a custom project where all the tiles are to be installed with no cuts; however, a cut piece or two may be needed to make the layout work, the tilemaker may be able to re-glaze the cut edge. Otherwise, use paint or felt tipped markers on cut edges after smoothing with a rub stone on the cut edge.
- Use a modified dry-set cement mortar as the adhesive instead of mastic (organic adhesive). Due to the variations in the tile thickness, back troweling may be needed.
- If a mosaic is paper face-mounted, the paper is to be soaked and removed after the tile has initially set. Once the paper is removed, adjust the tiles for alignment.
- If tiles have a relief surface or have raised areas, tape these areas before grouting so grout does not get into all the crevices of the relief. Cleaning grout residue from the tile face can be very time consuming. Taping does take time, but the grout cleanup goes much quicker and uses less water in the process. (Note: If tiles will be taped for grouting, presealing the tiles makes it difficult to tape the tiles. Before presealing all the tiles, decide if taping is needed.)
- The application of a grout release may aid in the grout clean up.
- Electrical outlets can be challenging with handmade tiles due to warped or molded relief profiles. Using tiles with the least amount of warpage at these locations can be helpful.
- Handmade tiles require additional time to install – bid the job accordingly.
- Handmade tile installations require more allowance for waste which means more tile needs to be ordered initially. Additional tile may not be available in the same dye lot.
- Templating sections of the installation may be helpful but adds more labor. Determine if the site will provide enough space for templating the tile.
- Apply a better-quality mortar using a trowel notch that yields adequate mortar coverage and transfer to the back of the tile.
- Handmade tile installations require more time to complete than other tile installations (sorting, pre-sealing, educating the client, etc) – charge accordingly.
- Be a Certified Tile Installer (CTI).

Photo courtesy of Clay Squared to Infinity

Tile Not Manufactured to Industry Standards

MANUFACTURERS' STANDARDS

American National Standard Specification for Ceramic Tile A137.1, A137.2, and A137.3 are the only nationally recognized specification for ceramic tile.

Many domestic and foreign manufacturers of tile produce tile products made to the "manufacturer's own standards."

In many cases, these standards allow variation in shade, density, consistency of texture, wear resistance, absorption, fractures, squareness, size, thickness, warpage, and mounting that are considerably less stringent than ANSI standards.

Some manufacturers make broad disclaimers in their literature, virtually relieving themselves of responsibility for owner dissatisfaction or for the performance and appearance of their products. Some disclaimers deny responsibility after the tile is installed.

Often, visual inspection prior to installation does not reveal inadequacies of the tile's performance or possible installation problems.


MSOE
EXIT
Bostik

Photo courtesy of the National Tile Contractors Association

9

GROUTS

Photo courtesy of New York Tilemakers

Chapter 9
Grouts

NTCA Problem-Solving Guide For Ceramic Tile Grout Installations:

Cementitious and Modified Cementitious Grouts:

100% Solids Epoxies and Furan Grouts:

NTCA Problem-Solving Guide for Ceramic Tile Grout Installations

Introduction

This guide is intended only to offer possibilities for causes, prevention, and correction of grout problems and is to be used with the judgment and experience of the individual craftsperson. There are inherent problems with all grouts, and particularly pigmented grouts.

In all cases, users should refer to the manufacturers for their requirements and recommendations for prevention, correction, and causes of grout problems. The specific causes listed are common to ceramic tile, but do not necessarily represent all problem areas. It is recommended that suggested corrective measures be tested in an inconspicuous sample area before proceeding with the total job.

The use of proprietary names is not intended to imply that those products are the only products suitable for the correction or prevention. Proprietary names are used strictly as a means of identifying a type of product.

Photo courtesy of NTCA Member Dilligence Flooring.

Photo courtesy of Snowbee Custom Tile

Grout Selection Guide

This document reprinted with permission from Tile Council of North America and taken from the Tile Council of North America Handbook for Ceramic, Glass, and Stone Tile Installation

NOTE

Specifications in this *Handbook* for the materials used to grout ceramic, glass, and stone tile have been developed according to the requirements and procedures of two standards-setting bodies: The American National Standards Institute (ANSI) and the International Organization for Standardization (ISO). These standards were developed with differing criteria and do not correlate with each other; they cannot be cross-referenced or used interchangeably. Both sets of standards are in widespread and common use in North America. Accordingly, each installation method in this *Handbook* provides grouting material specifications according to both sets of standards where applicable. For complete material properties and requirements, refer to the applicable ANSI or ISO standard or "Appendix A" in the *TCNA Handbook*

INTRODUCTION

Grouting materials for ceramic, glass, and stone tiles are available in many forms to meet the requirements of the different kinds of tile and types of exposures. Portland cement is the base for most grouts and is modified to provide specific qualities such as whiteness, mildew resistance, uniformity, hardness, flexibility, and water retentivity. Non-cement-based grouts such as epoxies, furans, and premixed polymer resin grouts offer properties not possible with cement grouts. However, special skills and precautions on the part of the tile setter may be required.

SAND-PORTLAND CEMENT GROUT

An on-the-job mixture of one part Portland cement to one part fine, graded, clean sand (ASTM C144) is used for joints up to 1/8" in width; 1:2 for joints up to 1/2" in width; and 1:3 for joints wider than 1/2". Up to 1/2 part lime may be added.

Sand-Portland cement grout can be used with ceramic mosaic tiles, quarry tiles, pressed floor tiles, porcelain tiles, some glass tiles, and some stone tiles on floors and walls. Damp curing is necessary. On stone tiles and glass tiles, make sure the surface will not be scratched by the sand in the grout; unsanded grout may be required. Unsanded grout is commonly used with polished calcium carbonate-based stones (see "Natural Stone Tile Selection and Installation Guide"). Some glass tile manufacturers require unsanded grout to prevent scratching on smooth glass tile surfaces (see "Glass Tile Selection and Installation Guide").

Complete installation and material specifications are contained in ANSI A108.10. This type of grout is not characterized by ISO criteria.

STANDARD CEMENT GROUT

Standard Unsanded Cement Grout: A factory-prepared mixture of cement, fine aggregate, and other ingredients to produce a water-resistant, dense, uniformly-colored material meant for joints 1/16" to 1/8" wide (nominal).

Standard Sanded Cement Grout: A factory-prepared mixture of cement, graded sand, and other ingredients to produce a water-resistant, dense, uniformly-colored material meant for joints 1/8" in width or greater.

Grouts in this category are suitable for grouting walls and floors subject to ordinary use. On stone and glass tiles, make sure the surface will not be scratched by sand in the grout; unsanded grout may be required. Unsanded grout is commonly used with polished calcium carbonate-based stones (see "Natural Stone Tile Selection and Installation Guide.") Some glass tile manufacturers require unsanded grout to prevent scratching on smooth glass tile surfaces (see "Glass Tile Selection and Installation Guide").

Complete installation and material specifications are contained in ANSI A108.10 and A118.6. For applicable ISO material specifications, see ISO CG criteria.

HIGH PERFORMANCE TILE GROUT

High Performance Unsanded Tile Grout: A factory-prepared mixture of cement and other ingredients, including a redispersible latex/polymer powder, to which only water is added at the jobsite, or a liquid latex admixture. When added in a latex form, it is added as a replacement for part or all of the mixing water. These grouts are designed for installation in joints 1/16" to 1/8" wide (nominal).

High Performance Sanded Tile Grout: A factory-prepared mixture of cement, sand, and other ingredients, including a redispersible latex/polymer powder, to which only water is added at the jobsite, or a liquid latex admixture. When added in a latex form it is added as a replacement for part or all of the mixing water. These grouts are designed for installation in joints 1/8" in width or greater. The maximum allowable joint width is designated by the grout manufacturer.

Grouts in this category provide improved characteristics such as increased bond strengths, flexural strengths, and lower water absorption to resist frost damage. On stone and glass tiles, make sure the surface will not be scratched by sand in the grout; unsanded grout may be required. Unsanded grout is commonly used with polished calcium carbonate-based stones (see "Natural Stone Tile Selection and Installation Guide"). Some glass tile manufacturers require unsanded grout to prevent scratching on smooth glass tile surfaces (see "Glass Tile Selection and Installation Guide").

Complete installation and material specifications are contained

Photo courtesy of Florida Tile

in ANSI A108.10 and A118.7. For applicable ISO material specifications, see ISO CG criteria.

GROUT COLOR SELECTION

Selection of a grout color that contrasts with the tile will emphasize the grout joint and correspondingly any variations in tile size and position. Selection of a similar or complementary grout color will de-emphasize such variations.

When a similar color grout is used, it is often more difficult to see the haze left after the initial grout cleaning and extra care must be taken to remove all haze.

STAIN RESISTANCE AND COLOR CONSISTENCY OF CEMENTITIOUS GROUTS

Color consistency and stain resistance vary depending on several factors: water absorption of the tile (with lower absorption generally producing a lighter shade), grout color chosen, whether polymer or water is used, amount of water used in mixing and cleaning, degree of curing before cleaning, grout compaction, joint depth, joint finishing, humidity, and many other parameters. In-field color can vary significantly from factory-prepared color samples, and many grouts are darker when wet.

While there is currently no industry standard to evaluate color consistency or stain resistance of cementitious grouts, there are grout formulations and/or admixtures available that allow for improved color consistency. Similarly, there are grout formulations, and/or admixtures, and/or sealers that allow for improved stain resistance by reducing the extent or severity of staining. Not all stains are affected similarly; consult grout manufacturers for application suitability and maintenance recommendations.

Regardless of the grout used and whether or not a sealer was applied, tile and grout can generally be cleaned by sweeping first and rinsing with water. In cases where excess dirt cannot be removed, use an alkaline or pH-neutral cleaner at the lowest effective concentration and rinse thoroughly to eliminate residue. Do not use oil-based cleaners, which are difficult to remove and entrap dirt.

EPOXY GROUT

Epoxy grout is a grout system employing epoxy resin and hardener portions, often containing coarse silica filler, especially formulated for industrial and commercial installations where chemical resistance is important. These grouts also provide high bond strength, impact resistance, and improved stain resistance. High-temperature, chemical-resistant formulas are also available. Chemical and stain resistance can vary between epoxies; consult grout manufacturers for application suitability, including exterior UV exposure and maintenance recommendations.

Complete installation and material specifications are contained in ANSI A108.6 and A118.3. For applicable ISO material specifications, see ISO RG criteria.

EPOXY EMULSION GROUT

Epoxy emulsion grout is a grout system employing epoxy resin and hardener portions, both of which contain additional water to form an emulsion. The coarse silica filler portion also contains Portland cement. These grouts are not designed for chemical resistance nor designed to meet ANSI A108.6 or ANSI A118.3.

Complete installation and material specifications are contained in ANSI A108.9 and A118.8. For applicable ISO material specifications, see ISO RG criteria.

FURAN RESIN GROUT

Furan resin grout is a grout system consisting of furan resin and hardener portions. Furan grout is used in industrial and commercial areas requiring chemical resistance. Use of this grout requires waxed tiles, special installation skills, and additional safety precautions when compared to all other grouts. Architects should select the type of furan grout applicable to the specified chemical and temperature exposure. This grout is not used with stone or glass tiles.

Complete installation and material specifications are contained in ANSI A108.8 and ANSI A118.5. For applicable ISO material specifications, see ISO RG criteria.

PREMIXED POLYMER RESIN GROUT

Premixed polymer resin grout is a one-part liquid ready-to-use grout that requires no mixing with water. These grouts may contain various types of water-based polymer including acrylics or urethanes and fillers that may be sanded or unsanded. The appropriateness of these grouts for commercial, water-exposed, and exterior applications varies widely; review and follow manufacturer recommendations before use.

There are no product or installation standards for this type of grout.

Photo courtesy of Daltile

Choosing Stain-Resistant Grout in Tile Specifications

Since the advent of colored grout used in tile and stone installations, maintenance and long-term appearance of grout joints have been ongoing topics of conversation with project owners and design professionals.

For decades, the choice of "a grout that doesn't stain" was limited to using ANSI A118.3 epoxy grouts. With low porosity similar to impervious porcelain tiles, epoxies are chemical and stain resistant. Over time, technology has made epoxy grout easier to install and maintain, so its popularity has grown from use in industrial applications and commercial kitchens to malls, light commercial buildings, and residential use.

This growth has led to the use of epoxy grout in installations where it may not be needed, leading to higher-than-necessary costs for materials and labor and potentially unnecessary exposure to chemicals that could cause allergic reactions with some individuals. Even with the advances in epoxy grout technology, they require an improved skill set, increased attention to detail for a successful installation and to avoid the costly cleanup of grout haze, and extra precaution toward mitigating risks of allergenicity.

Grout manufacturers have continued to make improvements to existing cement-based grouts as well, providing products with similar stain-resistance performance to epoxies. These products provide an alternative for projects where complete chemical resistance may not be required.

For example, polymer technology used in ANSI A118.7 cement grouts led to lower porosity. This is reflected in the water absorption requirements for ANSI A118.7 grouts, which are half (maximum, 5%) that of ANSI A118.6 grouts (maximum, 10%). Although cement grouts can stain with some problematic foods and oils, the lower porosity resists staining for a period of time. With proper cleaning, cement grouts can look new for the life of the project, especially if periodically sealed and maintained per manufacturer's instructions.

Grout technology has also outpaced industry standards with formulations including acrylic and urethane-based grouts commonly referred to as "single-component", "premixed" or "ready-to-use" grouts. As the porosity of these products is very low and being that they are somewhat "plastic" in composition, they are very difficult to stain and typically don't require sealing. They are less expensive than epoxy formulas so they may be a suitable alternative if high chemical resistance is not required. Since performance and installation standards are not yet available for these products, additional communication with the grout manufacturer regarding the intended use may be necessary.

Even with improvements to cement grout stain resistance and the advent of acrylic and urethane grout, conditions involving rigorous and extended exposure to certain foods, oils, or other staining agents, and/or scenarios where chemical resistance is needed may necessitate the use of epoxy grout. In these cases, epoxy's higher cost in labor and materials and the need for extra steps toward mitigating risks of allergenicity are likely justified.

When handling epoxy grouts, epoxy grouts generally contain corrosive chemicals and care is to be taken using personal protective equipment (PPE). As with all chemicals, some persons may have sensitivities to various components of products. These allergic reactions may appear in the initial exposure, but may can also occur after prolonged or continued use.

When installing epoxy grouts, it's important that care be taken using PPE. Epoxy grouts generally contain corrosive chemicals, and as with all chemicals, some individuals may have more allergic sensitivity than others. It's important to consider which PPE is needed. For example, gloves should be nitrile, not latex-based. They should be long enough to provide arm protection when rinsing a sponge or towel.

For vertical and overhead applications, shoulder length nitrile protective sleeves may be necessary. Wearing an apron, face shield, and hard hat may also help and of course, protective eyeglasses should be worn at all times. Care is to be taken to prevent epoxy and wash water from saturating clothes and all contact with skin.

In some cases, respirators may be required. Areas should also be well-ventilated during installation, and to protect others, signage should be placed so passersby can be aware of epoxy in use.

Project owners carefully choose grout to aesthetically complement tile and stone, so it makes sense that stain and chemical resistance are desired so that the color initially selected can be maintained throughout the life of the installation. With many stain-resistant options available, specifying the correct grout to meet the performance needs for each project is an important step in the materials selection process. Specifying the correct grout for each project satisfies the project owner, and choosing alternatives that fit usage balances the cost and well-being for all.

Latex-Modified Portland Cement and Modified Epoxy Mortars and Grouts

The use of latex modified portland cement and modified epoxy mortars and grouts increases the initial cost of materials and labor, but it usually increases the quality and durability of the installation. Learning to use latex products properly can substantially reduce labor cost. The following problems may be avoided with proper application and cleaning techniques, if they are recognized in advance.

1. **Substrate compatibility** – some substrates can be incompatible with specific types of mortars and grouts; i.e. coal tar waterproof membranes, substrates with coatings, etc. Refer to Chapter 2 of this manual and check with the manufacturer of the setting products for additional information.

2. **Cleanability –** follow NTCA's Bulletin "Latex Modified Grout" on page 256.

3. **Latex Migration or Bleeding** – migration or bleeding of latex is usually calcium carbonate (free lime), trapped in a film of latex. The presence of calcium carbonate in the form of free lime (efflorescence) is often mistakenly identified as latex migration. Refer to NTCA's Efflorescence document on page 258 for guidance in avoiding these problems.

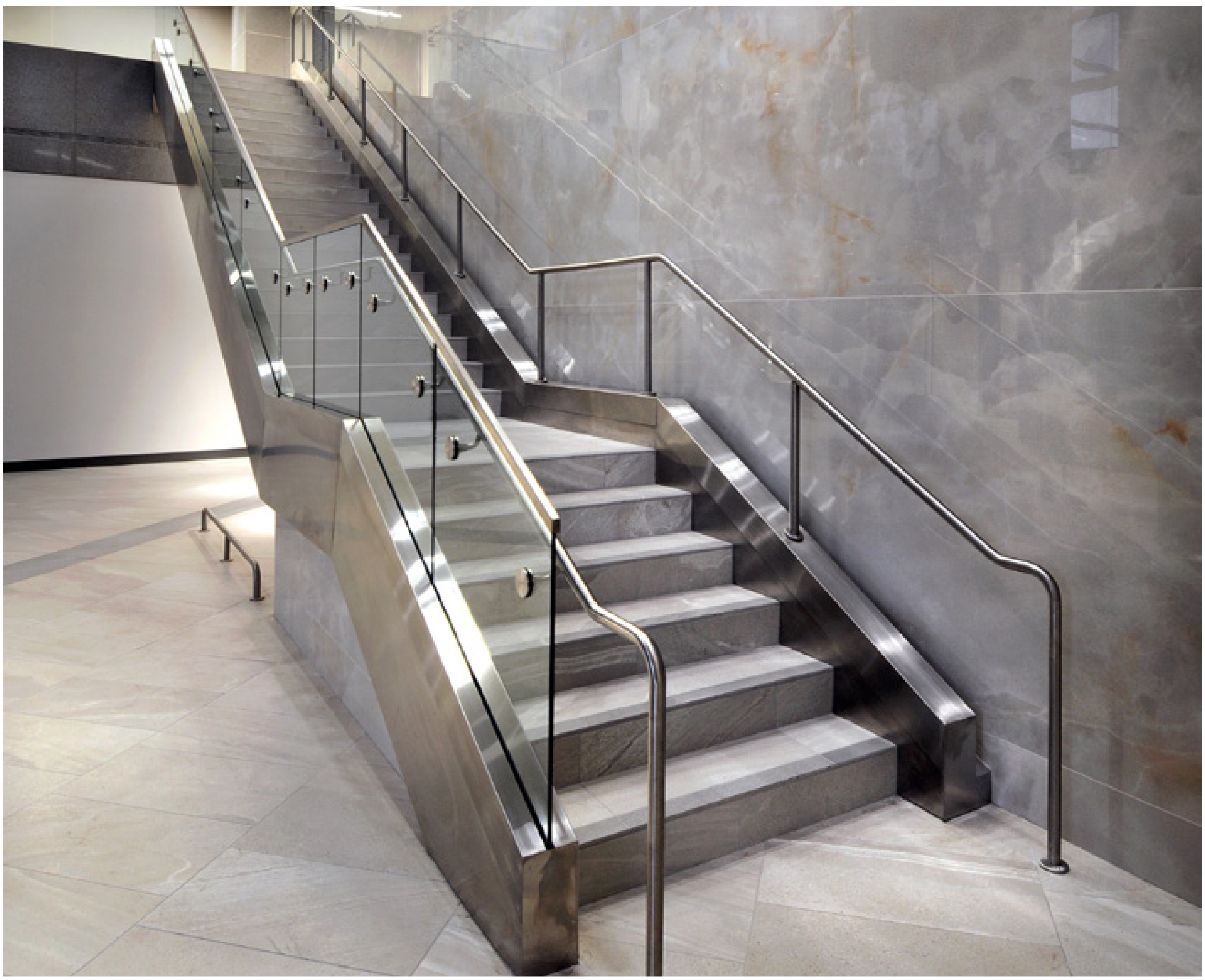


Photo courtesy of LATICRETE International.

Latex-Modified Grout

Developed and tested in NTCA Workshops

This procedure is primarily for floor tiles with 1/8" or wider joints; using commercial sand and cement grouts with latex additive. It is especially recommended for colored grouts. Unusually difficult cleaning problems are generally the result of a poor initial cleaning effort.

GROUTING
Prior to mixing the grout with water/latex, mix dry to evenly disperse ingredients, especially pigments that may have segregated during shipping and storage. Bags with multiple run numbers should be dry-blended together prior to mixing if used in the same area.

Grout must be properly mixed by hand or slow speed mixer to a stiff, low-slump consistency, allowed to slake for 5 to 10 minutes and then thoroughly re-mixed.

Dampen only the surface of the tile. Do not allow water in un-grouted joint areas.

Apply properly mixed grout with the appropriate grout trowel. Use force to achieve a full compact joint with no voids. After filling joints, remove as much excess grout as possible from the surface of the tile by holding the trowel at a 90° angle – and going across tiles diagonally from corner to corner. We emphasize… *for best results, you must hold the trowel at a 90° angle to the surface of the tile.*

CLEANING
Clean the remaining grout from the tile surface as promptly as possible.

- Fill two five gallon buckets three-quarters full of clean cool water. Wet a towel and wring out all excess water. Pull the flat dampened towel diagonally across the surface of the tile from corner to corner. This will remove remaining grout residue and smooth the surface of the grout joint.
- Continue this procedure by repeatedly washing and wringing out the towel in clean cool water. Change the wash water in the buckets often. A good indication that the water is too dirty for effective cleaning is a milky appearance on the tile surface.
- When finished, the tile should be very clean – with perhaps only a light haze remaining; and the joint surface should be smooth and even.

Clean the haze off the tile surface the next day using the following procedure:

- First, dampen a white nylon scrub pad with water and scour the surface of the tile to remove the haze.
- If any haze still remains, it may be necessary only to rub the surface of the tile using the white nylon scrub pad or nylon brush, dampened with a solution of sulfamic acid and water.
- Follow the manufacturer's directions for mixing the sulfamic acid solution. The white nylon scrub pad, dampened with sulfamic acid, suspends the residue being removed from the surface of the tile while the sulfamic acid acts on the cementitious residue.

It is important to note that no acid solution is applied directly to the floor. All acid washed tile and grout surfaces must be rinsed with an alkaline pH rinse in order to ensure that all acidic residues are effectively neutralized. This may be accomplished by simply adding a small amount of an alkaline pH cleaner or ammonia (amines) to the rinse water.

If a persistent haze still remains on the tile surface you can – at this point – use a white mild abrasive compound with a white heavy-duty scrub pad to remove it. Rinse thoroughly. Polish the tile surface if necessary.

NOTES
This procedure has proven consistently good results on a variety of latex additives. The degree of success is dependent on how closely the entire procedure is followed. The heavy-duty scour pad is used for its scouring capacity to break up the latex film.

Latex additives for grout were provided by many of the major manufacturers and each sample was used in the development of this procedure. A wide cross-section of tile products was used. In each case, this procedure worked effectively.

Contact your local ceramic tile distributor for the products required for this procedure. Large heavy-duty scouring pads for floor polishing machines are also available through most janitorial supply companies.

CAUTIONS
1. Pre-soak all surfaces before applying sulfamic acid or phosphoric acid cleaners.
2. Ascertain that acid will not damage tile surface to be cleaned.
3. Ascertain that scrub pad will not scratch surface to be cleaned.
4. Some products require a grout release agent or pre-sealing prior to application. If such a product was used, a different cleaning procedure may be required.

This procedure is referenced elsewhere in this manual as NTCA's Bulletin
"Grouting and Cleaning Ceramic Tile Floors with Latex Grout."

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Efflorescence

Whitish powder or crusty crystalline deposits appearing on the joint or along the edge of the tile.
In porous tile, efflorescence may appear on the surface of the tile.
Potential for efflorescence is always present in Portland cement based setting and grouting systems.

Problem

Soluble salts from the Portland cement based setting or grouting material or sub surfaces, brought to the surface by capillary action where there is water or moisture present.

Contaminated water or sand containing soluble salts.

High sodium chloride content caused by some water softeners or concrete accelerators.

Free lime.

Porous grout from rapid mixing.

Omission of vapor barrier or damaged vapor barrier under slab.

Excessive water in setting or grouting mix.

Excessive water and soaking during clean up.

Uncured slabs containing soluble salts.

Water penetrating a soluble salt contaminated joint, setting bed, or cementitous substrate and wicking to the surface.

Improper cure under polyethylene.

In some rare cases, soluble salts are present in the tile itself.

Excessive mineral content (well water) used for the grout installation, also the water used for tile maintenance.

Adding water to the grout to prolong grout life. (Retempering).

Grouting too soon after installation of tile.

Prevention

Efflorescence is inherent in exterior tile installations and can only be minimized by following these recommendations.

Maintain installations at or above minimum temperatures as recommended by manufacturer.

Minimize moisture or passage of moisture through the setting beds or joints. Allow for proper cure.

Use the amount of water or additive recommended by the manufacturer of the mortar and grout. Grout should be installed as firm as possible but left pliable enough to be packed into the depth of the grout joint.

The use of latex additives specifically designed for mortar bed and grout may reduce efflorescence.

Use kraft paper in lieu of polyethylene for curing. Use a breathable paper.

Compactly install a tight, dense grout joint.

Use a silicone or acrylic grout sealer after proper curing.

Use hydrated lime when required.

Use factory-prepared grouts.

Use adequate underbed drainage; and where moisture can enter from the back surface, use a moisture barrier.

Before grouting, verify that excess moisture has left the slab and setting bed.

Install tile with maximum coverage.

Consider using moisture mitigation membranes when excessive moisture is detected.

Consider the use of mortars, grouts and membranes that reduce the possibility of efflorescence.

Cure

Any of the following may be a cure to problems with efflorescence.

Some efflorescence can be removed merely by using a stiff bristle brush, either dry or with clean water.

Clean with sulfamic acid or phosphoric acid cleaner. Caution must be used to avoid damage to grout joint. Thorough rinsing with clean water is necessary.

In some cases, a deep penetrating grout sealer will reduce moisture penetration and thereby prevent wicking.

Some manufacturers' sealers will, through repeated application and cleaning, force out the elements of efflorescence and eventually seal the mortar and grouts.

In some cases, time will allow the soluble salts to dissipate.

For marble and natural stone, refer to Chapter 8.

Select area for testing. Clean and seal with recommended system.

Call the grout manufacturer when acid cleaners do not yield results.

* In some cases latex migration may appear to be efflorescence.

* Never use a grout sealer on installations until the grout color is satisfactory.

Problem	Prevention	Cure
(continued from previous page) Grouting below recommended minimum temperature. Exterior brick, block, stucco, mortar, or any other Portland cement based products can effloresce and could be source of problem.	*(continued from previous page)* During cold weather, the tile, substrate, water, latex, and grout should be maintained at minimum temperature before and after grouting as recommended by the manufacturer. In cold temperatures protect exterior wall and floor installations from water for 72-96 hours after installation to facilitate sufficient curing. Latex modified installation systems must be dry cured.	

Efflorescence is seen here due to an uncured slab. Photo courtesy of Dave Gobis.

Latex Migration

White, rubbery substance coming through the joints. Similar in appearance to efflorescence. Unlike powdery efflorescence, latex residue will be rubbery.

Problem	Prevention	Cure
Using latexes for applications not specifically recommended by the manufacturer; or failure to follow manufacturer's instructions.	Use only latex recommended by the manufacturer for the specified use. Thoroughly mix latex with the grout or setting bed material using a mixer with 300 rpm or less. Strict adherence to manufacturer's recommended mix and use.	These suggested corrections and/or a combination of suggested corrections may provide improved conditions and a serviceable product. There is a correlation between the Problem and Prevention columns. ***Any of the following may be a cure to problems with latex migration.*** Clean latex off surface with a non-metallic scouring pad and a latex cleaner. Latex residue can be removed with solvent-based strippers similar to those used to strip paint and epoxy. Always conduct a test area to verify results. Select area for testing. Clean and remove latex residue. Allow for proper curing and dissipation of moisture. Seal with recommended water repellent. For marble and natural stone, refer to Chapter 8.
Too much liquid (water/latex) in the setting bed or grout material.	Mixes must be very stiff with a zero slump.	
Latex not allowed to dry out thoroughly prior to wet uses, such as swimming pools and gang showers.	Cure 14 to 60 days – depending on temperature, humidity, and water exposure.	
Latex installations exposed to freezing or rain during the curing period.	Protect installation from weather extremes (freezing or rain) during the curing period.	
Using latexes of manufacturers whose testing has not included all environments and job applications.	Have manufacturer specifically approve, in writing, the specified installation for the use of that manufacturer's material.	
Grouting before excess moisture has escaped the setting bed and substrate.	Before grouting, allow a minimum of 48 hours for excess moisture to escape setting bed – with consideration of geographical location, weather conditions, and tile size.	
Cold, damp conditions during or right after setting or grouting can cause latex not to cure and possibly migrate through the grout joints.	Thoroughly mix using a mixer with 300 rpm or less. Latex mortars and grouts must be dry cured.	
Water entering the open expansion joints and behind the installation during construction.	Check flashing at roofs and windows. Check expansion joints for possible replacement and any other areas that have been caulked to prevent moisture from entering. Caulk immediately after grouting.	

Crazing and/or Cracking of Grout Joints

<table>
<tr><th>Problem</th><th>Prevention</th><th>Cure</th></tr>
<tr><td>High absorption of tile.</td><td>Dampen tile surface before grouting.

Use latex modified grout.</td><td rowspan="7">These suggested corrections and/or a combination of suggested corrections may provide improved conditions and a serviceable product. There is a correlation between the Problem and Prevention columns.

Any of the following may be a cure to problems with crazing and/or cracking of grout joints.

Limit movement in substrate, bonding material, or tile.

Use a recommended latex grout mixture specifically formulated for this purpose. Several manufacturers make a product for this use. Check with the manufacturer to confirm his recommendation for this special use.

To correct fine cracks, use a latex grout additive and non-sanded grout. Use a fine sand with a latex/cement mix to correct larger cracks.

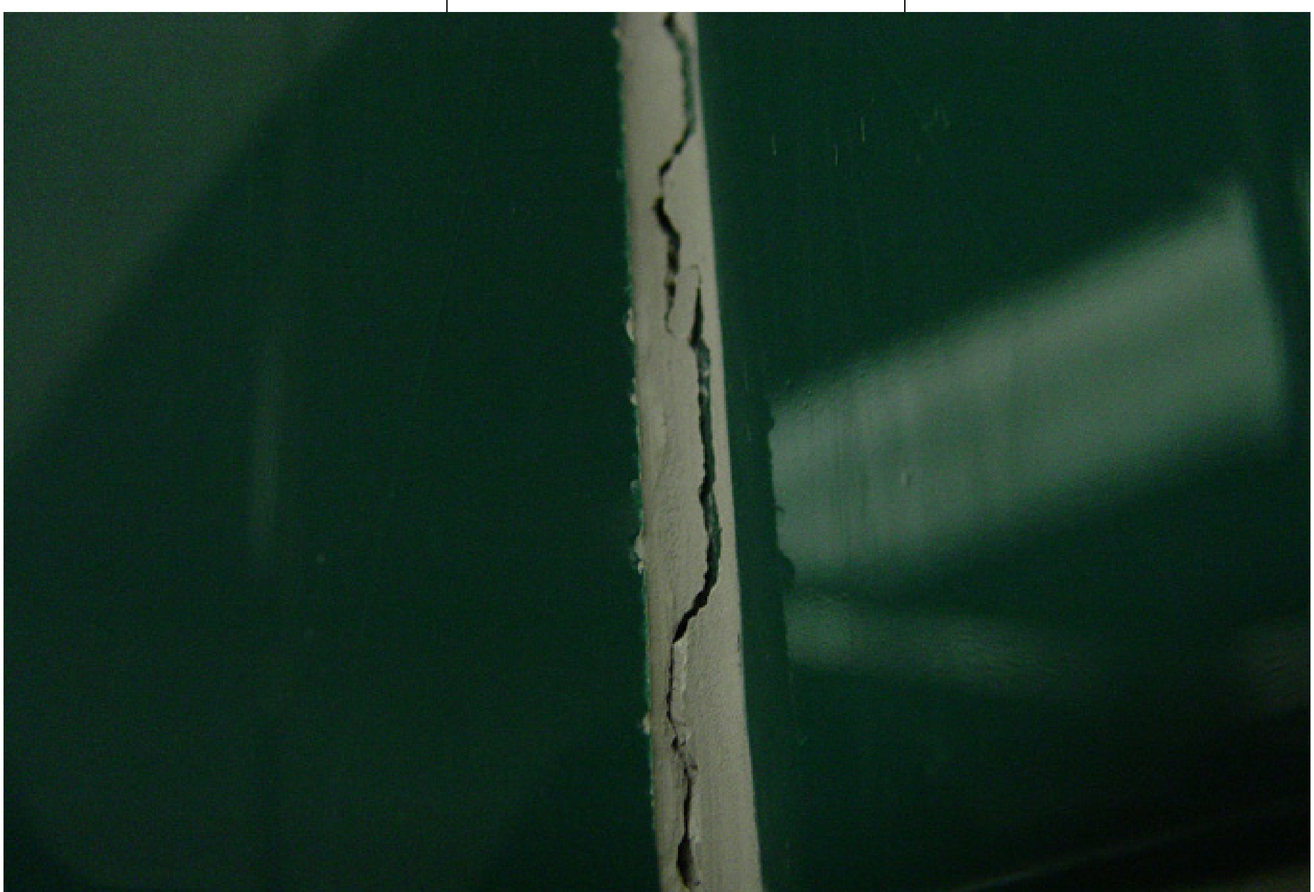
Seal with penetrating and hard-drying sealer.</td></tr>
<tr><td>Movement in substrate, tile, or bonding material.</td><td>Deflection to meet building requirements and expected live and dead service loads.

Use crack-isolation membrane over existing cracks in the substrate, following manufacturer's recommendations.</td></tr>
<tr><td>Improper gradation of sand or not enough sand.</td><td>Use proper gradation of sand as specified in ANSI A108.</td></tr>
<tr><td>Improper curing caused by high temperature, fast-drying winds, failure to damp cure and dry slab.</td><td>Damp cure non-latex grout for 72 hours under kraft paper. Certain conditions such as high temperature and fast-drying winds may require damp curing of latex grouts. Follow manufacturer recommendations for grout cure.</td></tr>
<tr><td>Improper selection of grout for specified use and size of joint.</td><td>For manufactured grout, use grout recommended for the specified use and size of grout joint.</td></tr>
<tr><td>Thin grout surface with underlying voids.</td><td>Fill all grout joints with grout material a minimum of 2/3 of the thickness of the tile used.</td></tr>
<tr><td>Improper mixing:
• Air entrapment in grout from high-speed mixing or over-mixing.
• Too much liquid (water or latex).
• Inadequate mixing.
• Adding water and retempering.
• Mix too rich.</td><td>Use slow-speed mixer not exceeding 300 rpm.

Use proper liquid ratios according to manufacturer's instructions or ANSI A108.10 recommendations.</td></tr>
</table>

Crazing and/or Cracking of Grout Joints

Problem	Prevention	Cure
(continued from previous page) Washing with excess water.	*(continued from previous page)* Follow recommendations in NTCA grouting and cleaning procedure in Chapter 8. Avoid excess water in cleaning.	
Lack of proper expansion joints.	Install proper expansion joints in accordance with recommendations in *TCNA Handbook* Method EJ171.	
Material subjected to freezing conditions during curing process.	Do not subject grouting materials to temperatures below manufacturers' recommendations during grouting and curing stages.	
Absorption differences due to variation of glaze on tile edge.	Use a latex-modified grout.	



Low Grout Joints

Grout not up to tile edge

Problem	Prevention
Joints not filled properly during application.	Careful grouting techniques and close inspection of joints during grouting process. Pack joints full using stiff grout mix.
Using too much water and washing grout out of joints.	Follow recommendations in NTCA procedure for grouting and cleaning ceramic floors with latex grout. Recommendations apply to both standard grouts and latex-modified grouts.
Using soft float or sponge in grouting process.	Use of proper trowel/float is recommended.
Joints settling as a result of voids under edges of tile.	Provide and obtain full coverage at tile edges with setting material.
Improper selection of grout for specified use, and size of joint.	Use grout recommended for the specified use and size of joint.
Strong acid cleaning or using acid too early after grouting.	Avoid use of acid cleaning whenever possible. **When acid cleaning is necessary, wait at least three days before applying acid. (Follow manufacturer's instructions)** Soak tile and grout with water before cleaning with a solution of sulfamic acid in room temperature water, followed by a thorough rinsing with clean water. Note: A cup of non-sudsing household ammonia per 5 gallons of water should be added to the rinse water to assure the surface is chemically neutralized. A hose with an atomizer attachment (like for seed or fertilizer) containing the non-sudsing household ammonia can be used to provide the proper water/ammonia mix

Cure

These suggested corrections and/or a combination of suggested corrections may provide improved conditions and a serviceable product. There is a correlation between the Problem and Prevention columns.

Any of the following may be a cure to problems with low grout joints.

Use a recommended latex modified grout topping mixture compatible with the existing product and specifically formulated for the purpose of completely filling the joints.

Note: Sealers should not be used. If a sealer is in place, remove it completely.

Thoroughly clean the existing grout surface and make certain the remaining grout is sound.

If most of the grout joints are low, the balance of the joints should be made approximately the same depth to avoid a non-uniform appearance in the repaired installation.

Most manufacturers will require dampening (no standing water) the existing grout joints prior to the application of the cementitious topping material. This prevents the existing grout from robbing the water/gauging liquid from the new application. If this is not done, the work will fail.

Pinholes in Grout Joints

Problem	Prevention	Cure
Grout mix too wet.	Correct liquid to powder ratio.	These suggested corrections and/or a combination of suggested corrections may provide improved conditions and a serviceable product. There is a correlation between the Problem and Prevention columns. ***Any of the following may be a cure to problems with pinholes in grout joints.*** Dampen joint and point up with latex modified grout. Wall tile joints can be grouted over with a slurry of tile grout. Pointing up individual holes. Associated with pinholes is soft grout. Regrout when necessary.
High-speed mixing entrapping air in grout mix.	Proper mixing, using slow-speed mixer not exceeding 300 rpm.	
Too much water used in cleaning.	Follow recommendations in NTCA grouting and cleaning procedure.	
Tile with high absorption.	Fully pack grout joints with float to avoid trapping air.	

Pinholes in grout joints can result when the grout mix is too wet.

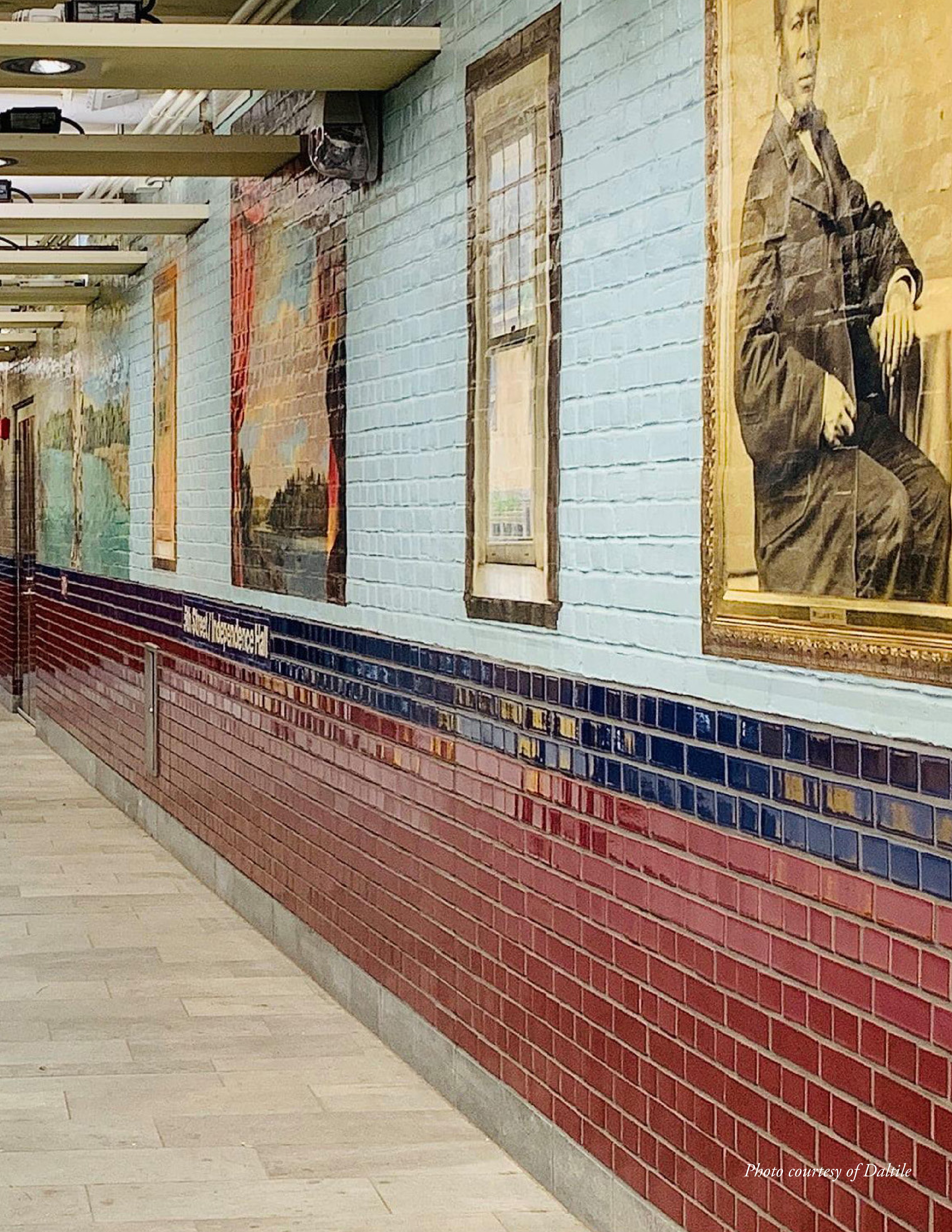


Photo courtesy of Daltile

Powdery or Soft Grout Joints

Joints that do not harden or that have powdery surface residue.

Problem	Prevention
Failure to damp cure.	Damp cure with kraft paper for 72 hours to ensure proper curing.
High temperature, hot air flow, or dry environment.	Control loss of moisture in rapid drying and windy conditions such as installations exposed to direct sun. Grout in a tented or shielded area.
Exposure to freezing within three days.	Install and cure within recommended temperature ranges. Protect from freezing.
Cleaning with highly concentrated acid cleaners.	After 3 days, if acid cleaning is necessary, presoak joints with water and clean with sulfamic acid or other manufactured cleaner with controlled acid effect. Thoroughly rinse and neutralize.
Use of old or damp grout that is partially hydrated before mixing. Contaminated water or sand. Re-tempering the grout mix.	Use fresh materials from factory sealed bags and clean, potable water. Have questionable materials tested. Store grout in dry, protected areas.
Improper proportioning of grout ingredients.	Follow *TCNA Handbook* for proper proportions of grout ingredients or use factory-prepared grout.
Improper selection of grout for specified use and size of joint.	For manufactured grout, use grout recommended for the specified use and size of joint.
Improper mixing or failure to slake grout.	Use low-speed mixer, not exceeding 300 rpm. Allow grout to slake.
High absorption of tile, preventing proper hydration of grout.	Presoak highly absorbent tile or use a grout designed for highly absorbent tile.
Foreign materials in the joint, such as dust, plaster, gypsum, joint compound, etc.	Thoroughly clean foreign materials and debris from joints before grouting.
Excessive liquid in mixing and/or cleaning.	Accurately measure the liquid according to manufacturer's directions for mixing and avoid use of excessive water in grout clean-up.
Petroleum-based sealers applied prior to hydration of grout.	Allow grout to hydrate prior to applying petroleum-based sealers.

Cure

These suggested corrections and/or a combination of suggested corrections may provide improved conditions and a serviceable product. There is a correlation between the Problem and Prevention columns.

Any of the following may be a cure to problems with powdery or soft grout joints.

Installations not properly damp cured initially may be damp cured later; often with good results. Rehydrate with water for several days.

Apply grout hardener after installation.

Grout damaged by freezing must be replaced.

NOTE: Use of latex modified Portland cement grout offers added protection from powdery and soft grout joints.

Rough-Textured Grout Joints

Problem	Prevention	Cure
Heavy or repeated acid washing.	If acid cleaning is necessary, presoak joints with water and clean with sulfamic acid or other manufactured cleaner with controlled acid effect.	These suggested corrections and/or a combination of suggested corrections may provide improved conditions and a serviceable product. There is a correlation between the Problem and Prevention columns. ***Any of the following may be a cure to problems with rough textured grout joints.*** Rough and depressed joints can be regrouted with latex modified grout and fine aggregate. Rough full joints can be regrouted with latex modified Portland cement grout topping without aggregate – follow manufacturer's directions for preparation, procedure, and curing requirements. Remove all loose grout before attempting to regrout or apply grout topping.
Wet sponge washing cement away from aggregate.	Avoid excessive water in mixing and cleaning. Accurately measure the liquid according to manufacturer's directions for mixing and avoid use of excessive water in grout clean-up. Apply grout with properly selected trowel/float. Use proper sponging technique.	
Incorrect ratio of cement to sand.	Follow *TCNA Handbook* for proper proportions of grout ingredients or use factory-prepared grout.	
Incorrect aggregate gradation.	Use proper sand gradation for the specified joint size.	
Incorrect selection of grout for specified purpose. Incorrect washing technique.	Get specifier's prior agreement to grout texture.	

Inconsistent Grout Color

Light and dark areas of grout, mottled, spots, streaks, or yellowing of white grout. Notwithstanding an installer's best efforts and adherence to recommended procedures, discolored and/or inconsistent grout colors will often occur due to the inconsistent nature of cement.

Problem	Prevention
Grout mixed too wet.	A stiff, consistent water ratio grout mix, properly slaked.
Grout not cured properly or consistently.	Damp cure consistently with 40 lb. kraft paper for 72 hours to ensure slow, even curing.
Inconsistent joint sizes.	Maintain uniform grout joint depth and width.
Cleaning acid concentration too strong, used too early, used on dry joints, or inadequate rinsing after acid wash.	Do not use muriatic acid. Avoid cleaning too early with acid type cleaners. Wet grout joints before cleaning and thoroughly rinse afterwards.
Too much water used in grout cleaning procedure. Grout not sufficiently mixed or improperly mixed by hand with trowel or hoe; mixing too fast with high speed drill; or mixing in dirty or contaminated containers.	Reduce water during cleanup. Dry blend grout when uniformity is not a manufacturer-assured, quality control factor. Dry blend entire bag. Machine mix grout materials at 300 rpm or less. Mix in clean containers.
Inconsistent absorption of highly absorbent tiles. Glaze on some edges of tile. Scored tile.	Use latex additive specifically designed for grouting. High absorption tile should be uniformly wet prior to grouting with commercial Portland cement grout.
Grouting done by different grouters and under different environmental conditions.	When possible, use same craftsperson throughout an area and maintain consistent environmental conditions. Avoid concentration of direct sunlight, heat, or air flow such as space heaters, air conditioners, and draft areas during installation and curing.
Setting material inconsistent in the upper 2/3 of grout joint.	Rake out high ridges of setting material from the joints prior to grouting to ensure uniform grout thickness.
Spacers left in tile joints.	Remove spacers.

Cure

These suggested corrections and/or a combination of suggested corrections may provide improved conditions and a serviceable product. There is a correlation between the Problem and Prevention columns.

Any of the following may be a cure to problems with inconsistent grout color.

Consult manufacturer prior to applying any corrective material. Many treatments suggested here may inhibit correction measures that may be recommended by the manufacturer.

Dampen and continue damp curing with 40 lb. kraft paper.

On dark grout only – lightly brush with wire brush.

Pre-wet and try recleaning with sulfamic acid or other manufactured cleaners with controlled acid effect. Thoroughly rinse with clean water.

Permanently stain grout joint with grout colorant manufactured for this purpose.

Reclean with a neutral pH cleaner.

White Tile Grout Yellowing:
Apply a pumice of oxalic acid or naval jelly only as a temporary correction.

Apply household bleach followed by a penetrating sealer.

continued...

Inconsistent Grout Color

Problem	Prevention	Cure
(continued from the previous page) Cleaning with water prior to initial set of grout.	*(continued from the previous page)* Allow grout to acquire initial set before cleaning with water.	*(cures found on the previous page)*
Damp curing with polyethylene.	Damp cure consistently with 40 lb. kraft paper for 72 hours to ensure slow, even curing.	
Sealed with sealer not specifically made for the purpose; or sealer applied too early.	After damp curing and proper hydration, apply sealers according to manufacturers' recommendations.	
Gypsum dust from drywall or plaster, or dirt and dust from construction conditions.	Protect the finished grout from construction debris.	
Residue from materials used in initial cleaning and maintenance procedures.	During initial cleaning, remove the residue of grout from both the tile surface and the surface of the grout joint. Furnish maintenance personnel with proper maintenance instructions.	
Insufficient curing time allowed for the setting material or substrate before grouting.	Follow the setting material manufacturer's instructions for curing time required before grouting.	
White Tile Grout Yellowing: Sand used in the mortar bed may contain iron, iron oxide or clay.	Use prepackaged floor mud. Use cleaned and dried bagged sand from a reputable supplier.	
Trace amounts of sulfur compounds from temporary heating systems such as salamanders.	Discontinue use of the heating system or use another type. Provide adequate ventilation. Grout colorant	
Other possible causes of inconsistent grout color: • Different grouting material batch numbers. • Grout not properly slaked. • Use of partial bags of grout where ingredients have separated. • Use of contaminated water or water with a high mineral or salt content. Example: well water • Variations of raw materials supplied to the manufacturer may result in slightly inconsistent grout color from batch to batch.		

Photo courtesy of NTCA Member Modern Room Remodels.

Grouting with 100% Solids Epoxy or Furan Grouts

INTRODUCTION

What does 100% solids grout mean?

By definition the solids content is nearly 100%, not just a high solids content where a solvent, water, or hybrid is used in the production that will evaporate in the curing process.

What is the chemistry behind an Epoxy Grout?

Epoxy grouts use a mixture of organic epoxy resins that are epoxy functional pre-polymers and a hardener solution that usually is made from organic amines. The epoxy group is also sometimes referred to as a glycidyl or oxirane group on the material safety data sheets that come with the grout. A wide range of epoxy resins are produced industrially. The raw materials for epoxy resin production are today largely petroleum derived, although some plant derived sources are now becoming commercially available. Epoxy resins are polymeric or semi-polymeric materials. The epoxy resins are produced in such a way that they work best when very exact amounts of the hardener are added. If too much or too little hardener is added, the final polymer matrix that makes the grout perform will be severely compromised and can cause failures on the job site. It is critical to mix all the contents of the epoxy grout kit exactly as directed and not leave out some of the hardener to get best results.

Health risks:

The primary risks associated with epoxy use come from both the hardener component and the epoxy resin itself. Amine hardeners are generally corrosive and may burn unprotected skin. Some known hardeners may also be classed toxic and/or carcinogenic or mutagenic. Aromatic amines present a particular health hazard (most are known or suspected carcinogens), but their use is now restricted to specific industrial applications, and safer aliphatic or cycloaliphatic amines are commonly employed in most grouts on the market today.

Liquid epoxy resins in their uncured state are mostly classed as irritant to the eyes and skin, as well as toxic to aquatic organisms. Solid epoxy resins are generally safer than liquid epoxy resins, and many are classified non-hazardous materials. One common risk associated with epoxy resins is sensitization over time. The risk has been shown to be more pronounced in epoxy resins containing low molecular weight epoxy diluents. Exposure to epoxy resins can, over time, induce an allergic reaction. Sensitization generally occurs due to repeated skin exposure (e.g. through poor working hygiene and/or lack of protective equipment) over a long period of time. Allergic reaction sometimes occurs at a time that is delayed several days from the exposure. Allergic reaction is often visible in the form of dermatitis, particularly in areas where the exposure has been highest (commonly hands and forearms). It is absolutely necessary to wear the proper personal protective equipment when working with epoxy systems and to avoid all direct skin contact.

Typical applications for Epoxy Grouts:

Commercial kitchens, industrial food and beverage facilities, and anywhere chemical cleaning exceeds standard grouts limitations. The high stain resistance of these products has caused their use in residential and institutional construction to grow dramatically over the past 15 years. This trend is expected to continue.

INSTALLATION RECOMMENDATIONS AND BEST PRACTICES

I. Caution – Voids underneath tiles that open into grout joints contribute to low grout joints and pinholes. (*See "Cure" column on page 277.*)

II. Preparation – Clean tile surface and joints before grouting.

III. Mixing – These are general guidelines. Follow the individual manufacturer's specific instructions for their products.

A. Wear nitrile rubber gloves and avoid skin contact. Wash all exposed skin especially the hands and face immediately if contact is made. Remove contaminated clothing immediately. Follow all manufacturer personal protective equipment recommendations as listed on the Safety Data Sheet (SDS).

B. Use full units or measure components accurately by weight or volume according to the manufacturer's instructions. Full transfer of all liquids into the mixing container is critical to proper grout cure and performance.

C. Mix until uniform with a low speed mixer.
   1. If system contains 3 components, mix the components according to manufacturer's recommended sequence.
   2. High speed mixing will entrain air causing pinholes and low strength.
   3. Vigorous prolonged mixing will raise the temperature and reduce pot life.

D. Optimum working temperatures are 70° to 80°F.
   1. Store epoxy components at 60° to 90°F for a minimum of 24 hours before use.
   2. Temperatures above 80°F reduce pot life and open time.
      a. Pour *all* of the material out of the mixing bucket onto the floor or use a mortar board for walls to prolong working time or "pot life."
      b. If possible work during the coolest part of the day (or night).
      c. Do not use epoxies at temperatures above 90°F.
   3. At temperatures below 60°F epoxies become stiff.
      a. Use a space heater or an electric blanket to warm the substrate prior to installation.
      b. Some manufacturers have special formulations for low temperature applications.

IV. Grouting – The tools used are similar to those used in Portland cement grouting. However, the following points are particularly important with epoxies:

A. Allow 16 hours to elapse before grouting tile set in epoxy. Allow at least 48 hours after conventional or dry-set mortar setting is completed before grouting tile. Follow epoxy manufacturer's directions if a longer waiting period is required.

B. Use a hard rubber float
   1. Use sufficient pressure to force epoxy into and fill joints.
   2. Inspect for voids and fill immediately.
   3. Remove excess material from the tile surface using the float at a 90° angle to the surface and diagonal to the joints.

C. Walls and Vertical Surfaces
   1. Use a "Non-Sag" epoxy or additive recommended by the manufacturer.
   2. Some manufacturers have special formulation for less than 1/8" joints.

D. Joints grouted with epoxy shall be filled flush with tile edges. Provide a contoured depression no deeper than 3/64 inch (1mm) for a 1/4 inch (6 mm) wide joint, and 1/16 inch (2 mm) for a 3/8 inch (10 mm) wide joint (*See page 275)*.

V. Cleaning – The amount of time required before cleaning begins is the major difference in cleaning epoxy and Portland cement grouts. Follow manufacturer directions, but know that most epoxy products are cleaned shortly after the grout has been placed into the joint.

A. Before grout residue hardens on the surface of the tile:
   1. Use clean water and a white scouring pad to remove heavy residue, then a stiff sponge with square corners to dress joints. Some manufacturers suggest additives for the cleaning water. Be sure to follow all manufacturer recommendations.
   2. If grout pulls out of joints, use less pressure and more water.
      a. Check cleaning pad for burrs or irregularities to prevent tool marks.
      b. Colder water may stiffen epoxy in joints and prevent pull out of grout.
   3. Keep cleaning pad free of residue. Change cleaning water frequently.
   4. Drag tile with a damp turkish towel to remove haze.

B. After 2 to 14 hours (depending on temperature) remove remaining film with soapy water and a sponge or white scouring pad taking care to avoid disturbing the grout joint itself.

C. Inspect and remove *all* remaining epoxy residue from face of tile within 24 hours.
   1. Cured epoxies are very difficult to remove.
   2. Traditional (acid) grout cleaners are ineffective for cleaning epoxy, may cause discoloration and may affect grout curing.
   3. Proprietary epoxy cleaning products are available.
   4. Follow manufacturer's directions.
   5. Since some cleanup products damage the epoxy joints, it is very important that testing first be conducted on an inconspicuous area to determine its effects on tile and joints.
   6. Rinse installation thoroughly after cleaning.

Photo courtesy of Ege Seramik

SAMPLE LETTER FOR TILE CONTRACTOR

Date

Company
Address
City, State Zip

Re: Project

Please note that quality manufactured tile, installation products and grout have been installed in the project listed above. To protect these products from damage due to normal traffic use and to clean and maintain the installation, please follow the product manufacturer's recommended maintenance instructions for the tile and installation materials.

Note that not all cleaning products and methods are suitable for use on this installation. Use of such unsuitable cleaning products and methods may cause permanent damage to the grout and underlying installation systems. Such damage is beyond our control.

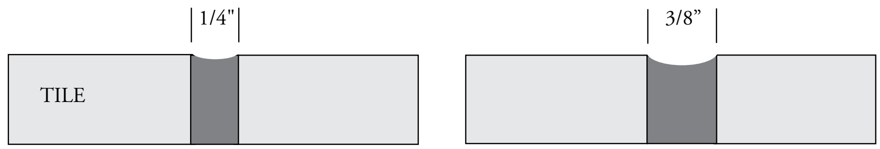
The use of cleaners and maintenance regimens that go beyond the tile grout and installation material manufacturer's maintenance instructions are the sole responsibility of the owner.

For further information, also consult the National Tile Contractors Reference Manual; The American National Standards Institute "Specifications for The Installation of Ceramic Tile" or other industry related reference documents.

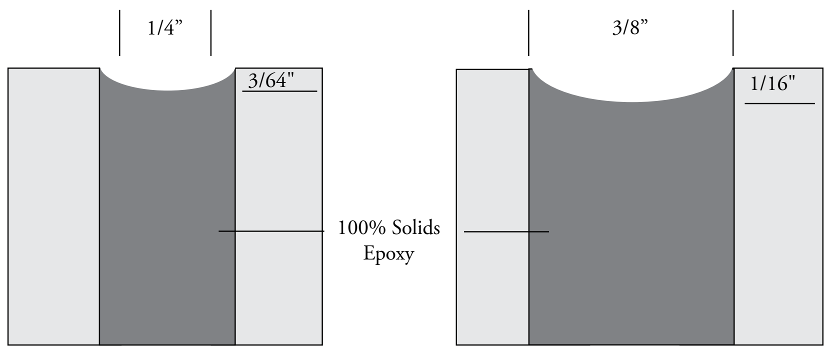
Name and Title
Company

ENC.

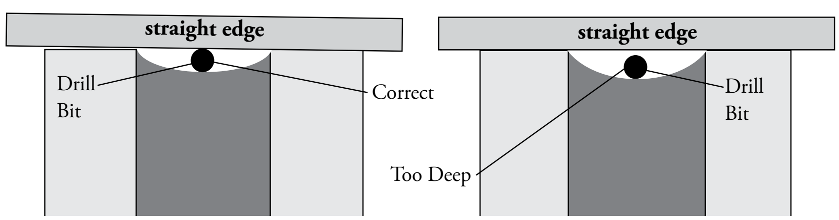
Acceptable Joints when Grouting with 100% Solids Epoxy



Acceptable Joints – Scaled To Actual Size



Detailed 3X Scale Drawing To Show Recommended Maximum Joint Depth In Finished Installation.



Detailed 3X Scale Drawing To Show Depth Measurement Using Machinists’ Drill Bits

Epoxy grouting systems employ resin and hardener portions and a variety of fillers that are especially formulated for industrial, commercial and residential installations where impervious chemical resistant grout joints are of paramount importance. Most manufacturers provide multiple epoxy based grouting products with different performance characteristics. Epoxy grout should be selected based on the service level and intended maintenance procedures of the product. High-temperature, chemical-resistant formulas are also available. The grouts also provide high bond strength and impact resistance. They impart structural qualities to the tile when used both as a mortar and grout, especially over wood subfloors. Their use involves extra costs and special installation skills when compared to Portland cement grouts.

While perfectly flush epoxy grout joints are desirable, they are not attainable using normal grouting procedures. The slightly concave epoxy grout joint, however, is superior in performance in every way when tested against other grouting materials.

Joints grouted with epoxy shall be filled flush with the edges. Provide a contoured depression no deeper than 3/64 inch (1mm) for a 1/4 inch (6mm) wide joint, and 1/16 inch (2mm) for a 3/8 inch (10mm) wide joint.

To measure a 100% solids epoxy grout joint, place a drill bit in the grout joint (a 3/64 inch bit for a 1/4 inch joint – a 1/16 inch bit for a 3/8 inch joint) and place a straight edge across the bit. If it touches or rocks on the respective drill bit, it meets or exceeds the ANSI Specifications.

Low Grout Joints

100% Solids Epoxies/Furan Grouts

Grout not up to tile edge

Problem	Prevention
Joints not filled properly during application.	Use careful grouting techniques and closely inspect joints during grouting process. Pack joints flush with surface of square-edge tile and evenly to the depth of cushion of cushion-edge tile. Use a properly selected trowel/float.
Washing grout out of joints during clean-up.	Use sufficient amount of clean water for cleaning, but do not pour or hose water directly on grout joint.
Using improper or soft grout trowel/float during application.	Use a properly selected trowel/float.
Using soft sponge during cleanup.	Use a proper cleaning implement that is firm enough to bridge grout joints without slumping into the joint and removing grouting material.
Joints settling as a result of voids under edges of tiles.	Obtain full coverage of setting material around bottom edges of tile.
Tiles set unevenly or out of plane.	Set tiles to form an even plane.

Cure

These suggested corrections and/or a combination of suggested corrections may provide improved conditions and a serviceable product. There is a correlation between the Problem and Prevention columns.

Any of the following may be a cure to problems with low grout joints using 100% solids epoxies/furan grouts.

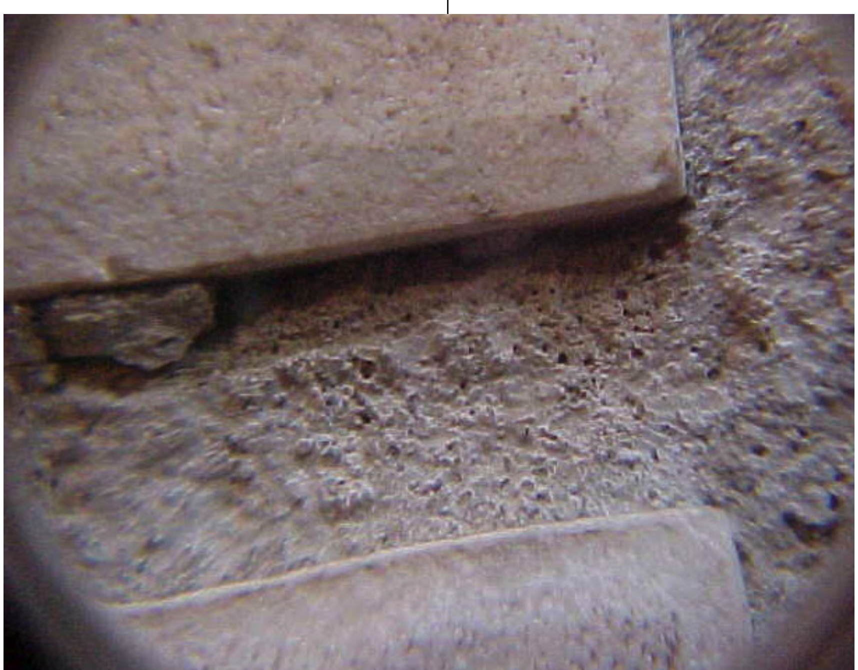
Most epoxy and furan grouting materials may be used as a topping on low joints of the same material to bring them up to an acceptable level. While minimum depths of approximately 1/8 inch are normally required to successfully top a low joint, check with the manufacturer for specific recommendations. All foreign materials must be removed from the surface of the grout joint prior to application of new material. Regrouting with furan-type grout must be accomplished prior to removing the protective wax from the tile surface.

Note to contractor: Some contractors experience successful results by striking the joints before grouting to block epoxy or furan from flowing into voids under tiles.

Pinholes in Grout Joints

100% Solids Epoxies/Furan Grouts

Problem	Prevention
High-speed mixing entrapping air in grout mix.	Properly mix, using slow-speed mixer not exceeding 300 rpm.
Excessive water and/or agitation applied to the grout joint during cleaning.	Use proper grouting and cleaning procedures.
Entrapping air under the grout during application. Air escapes leaving pinholes.	Force epoxy/furan using a hard rubber grouting trowel. Use sufficient pressure and flow epoxy/furan in progressively to avoid air pockets or voids.
Excessive air pockets underneath tiles. Thermal setting epoxies and furan materials displace the air and force it out through grout joints leaving pinholes.	Obtain adequate coverage of setting material around bottom edges of tile.



Cure

These suggested corrections and/or a combination of suggested corrections may provide improved conditions and a serviceable product. There is a correlation between the Problem and Prevention columns.

Any of the following may be a cure to problems with pinholes in grout joints using 100% solids epoxies/furan grouts.

Most epoxy and furan grouting materials may be used as a topping on low joints to bring them up to an acceptable level. While minimum depths of approximately 1/8 inch are normally required to successfully top a low joint, check with the manufacturer for specific recommendations. All foreign materials must be removed from the surface of the grout joint prior to application of new material. Regrouting with furan-type grout must be accomplished prior to removing the protective wax from the tile surface.

Pinholes are inherent characteristics of grouting with epoxies and furans materials, and best efforts will not completely eliminate all pin holes.

Note to contractors: Some contractors experience successful results by striking the joints before grouting to block epoxy or furan from flowing into voids under tiles.

Soft Grout Joints

100% Solids Epoxies/Furan Grouts

Joints that do not harden

Problem	Prevention	Cure
Improper proportioning of grout ingredients.	Always follow mixing instructions precisely. Mix complete units whenever possible.	These suggested corrections and/or a combination of suggested corrections may provide improved conditions and a serviceable product. There is a correlation between the Problem and Prevention columns. ***Any of the following may be a cure to problems with soft grout joints using 100% solids epoxies/furan grouts.*** In some instances, auxiliary heat may be needed to maintain the material within the manufacturer's recommended temperature range. If material has been contaminated with water or other products that have stopped the curing process, it may require removal and application of new material.
Improper mixing.	Always follow mixing instructions precisely. Mix complete units whenever possible. Never mix grouting materials with products not specifically recommended by the manufacturer. Mix with low speed power mixer, not exceeding 300 rpm.	
Materials and substrate below the temperature range required by the manufacturer before, during, or after grouting causing improper curing.	Maintain materials and substrate within the temperatures range required by the manufacturer before, during, and after grouting until material is fully cured.	
Applying grouting material to joints containing water and forcing the water to combine with the grout mix.	Do not grout over joints containing standing water.	
Using grout mixed with water removed during cleaning process to fill in voids.	Use sufficient amount of clean water for cleaning, but do not allow cleaning residue to be used as grouting material. Follow cleaning recommendations of the manufacturer precisely.	
Mixing grouting materials with other products that are not supplied or recommended by the manufacturer.	Never mix grouting materials with products not specifically recommended by the manufacturer.	
Grouting with old materials that have lost some of their chemical properties.	Use only fresh materials from previously unopened containers.	
Improper proportioning of grout ingredients.	Use only those materials and cleaning procedures specified by the manufacturer.	
Cleaning with materials other than those specified by the manufacturer.	Use only those materials and cleaning procedures specified by the manufacturer.	

Inconsistent Grout Color

100% Solids Epoxies/Furan Grouts

Light and dark areas of grout, mottled, spots, or streaks

Problem	Prevention	Cure
Grouting material not sufficiently mixed or improperly mixed, such as mixing with high speed drill, mixing in contaminated or dirty containers, not mixing entire contents of all required parts, etc.	Follow manufacturer's mixing directions precisely always being sure to mix proper amounts of the component parts. Mix with low-speed drill in clean containers, not exceeding 350 rpm.	These suggested corrections and/or a combination of suggested corrections may provide improved conditions and a serviceable product. There is a correlation between the Problem and Prevention columns. ***Any of the following may be a cure to problems with inconsistent grout color using 100% solids epoxies/furan grouts.*** Consult the manufacturer immediately to determine the cause of discoloration and the corrective measures. If sufficient depth can be obtained, some materials may allow reapplication or capping of the existing joint. Cleaning with a commercial detergent may solve some problems by removing residue of materials used in cleaning. If contamination or discoloration is on the surface only, various cleaning materials may be recommended by the manufacturer. Extreme caution should be exercised when using these types of materials. Precisely follow direction of the manufacturer and on the containers. Use epoxy compatible grout stain or colorant.
Setting material exposed in the grout.	Maintain joint depth, being sure that setting material does not exceed 1/3 the depth of the joint.	
Cleaning with contaminated water or cleaning utensils. Residue from materials used in cleaning.	Use fresh, clean water for cleaning epoxies, removing as much residue of cleaning material as possible as work progresses.	
Spacers left in tile joints.	Remove tile spacers prior to grouting.	
Cleaning with materials other than those recommended by the manufacturer.	Use only those materials and cleaning procedures recommended by the manufacturer.	
Grout not protected from other trades during curing process.	Protect from other trades.	

10

MAINTENANCE

Photo courtesy of NTCA Member
Timothy Steudeman of Built On Integrity, Sulphur Springs, Texas

Chapter 10
Maintenance

Mold
What it is and what to do about it

Molds are simple microscopic organisms called "Fungi" that are found in the environment. The majority of molds live in plant or animal matter and are necessary for life on earth. Mold is, in fact, the method by which nature cleans up unwanted matter on earth. Mold has existed since the earth was formed. It is only now, due to our improved tighter construction methods, that moisture is being trapped in our homes, causing mold growth problems. It is not necessary to spend time or money to identify the specific type of mold present; most customers consider all molds bad.

There are 3 basic categories of mold that are of interest to the ceramic tile industry:

1. Superficial, which is a maintenance issue.
2. Chronic existing mold, which requires professional mold remediation help, and
3. Potential mold, which is the main area of our concern. Preventing moisture intrusion will prohibit mold growth in the area of the tile installation. Mold requires 4 elements to grow: mold spores, temperature, food source, and moisture. The only requirement in the tile installation that can be controlled is moisture availability. Moisture control is, in fact, mold control.

WHAT TO DO WHEN MOLD IS DISCOVERED ON JOB

When you discover existing mold in an installation you must:

1. STOP. DO NOT proceed.
2. Notify all appropriate contractors/owners involved with the job. The liability of mold or its remediation is NOT the responsibility of the tile installer. However, mold issues for the tile contractor are usually straight forward. Identify the moisture problem and fix it. Clean or repair what the mold is growing on. DO NOT rebuild until dry. For further information go to "MDH Mold" or epa.gov/mold. Check with your specific state's health department as several states do have rules and regulations or laws concerning mold remediation.
3. Do not proceed with the job until ALL parties have signed off that the mold situation is addressed properly and that all concerns were satisfied.
4. To prevent mold from recurring, all tile assemblies should be installed carefully and correctly, including but not limited to using mold resistant materials. Moisture control products can be utilized to prevent any moisture from penetrating the tile work and possibly re-activating the mold.

The liability of mold or its remediation is NOT the responsibility of the tile installer

Recommendations for Exterior Tile Maintenance

1. Remove cracked and damaged tiles. Install replacement tiles and new joints with products recommended by the manufacturer as suitable for this purpose.

2. Clean and examine vertical and horizontal exterior tile surfaces annually before freezing weather begins. Since summer heat causes expansion joints and cracks to shrink, repair all expansion joint deteriorations using the proper sealants for vertical and horizontal applications.

3. After all joints and cracks have been repaired, allow the new sealant to cure and the surface to dry. Then apply a water-based silicone water repellent per manufacturer's recommendation to all horizontal and vertical surfaces of the tile and joints with a garden spray. This provides a water repellent surface without changing the normal appearance of the tile.

4. Repeat the procedure annually.

Photo courtesy of Daltile

Care and Maintenance

Given appropriate care and maintenance, properly installed ceramic tile and porcelain should provide a lifetime of beauty and function. Industry professionals, both at the distribution and installation levels, are encouraged to educate the customer or end user on critical issues such as sealing porous tile, stone and grout, slip resistance and basic care of the installation.

PRE-GROUTING SEALING

High porosity tiles and stones can be stained during the grouting process. To determine if the tile or stone requires a pre-grouting sealer (Grout Release) in order to protect from grout pigment staining and to facilitate grout clean up, it is recommended that a small test area be grouted and cleaned, especially where a contrasting colored grout will be used. If pre-sealing is needed during installation to protect the tile or stone surface from grout staining, a variety of grout release products are available. Follow floor manufacturer's recommendations for application and maintenance.

SEALING

Unglazed tile, natural stone and most grout (with the exception of 100% epoxy grout, ready-to-use grouts, and cement grouts with stain-inhibiting additives) are subject to staining if a sealer is not used. Many options exist today when considering a sealer for tile stone or grout. For glazed ceramic or glazed porcelain tile where protecting the grout is the primary concern, there are "grout sealers" designed for just this purpose.

When choosing a sealer, there can be a huge price variance, normally based on level of performance and longevity. Premium sealers are designed to provide a higher degree of stain resistance and provide a longer interval between re-application. Economical sealers usually provide a lower degree of stain protection and require more frequent re-applications.

Sealers can be solvent or water-based. Strict safety precautions should always be considered if a flammable, solvent-based sealer is used. Ventilation is also an important factor when using a solvent-based sealer. If an installation system includes a membrane or tile warming system, always check with manufacturers before using solvent-based sealers.

Sealers can be "penetrating" (impregnating) that are designed to completely penetrate into a porous surface and not change the appearance. They may also be a "coating-type"(topical) that are designed to bond to the tile or stone surface, providing either a matte, semi-gloss or gloss finish. Also, there are sealers designed to darken or color-enhance some porous tiles and some grouts. Penetrating (impregnating) type sealers should generally be considered if no change in surface characteristics or look is desired (check with manufacturer). Penetrating-type sealers are considered appropriate for the full range of porous tiles, stone and grout. Coating-type sealers are generally recommended for either textured or high- porosity surfaces such as saltillo, slate or terracotta when a surface sheen is required. Many coating-type sealers are not designed for exterior use. Color-enhancing sealers are designed for porous tile and grout where the primary purpose is to achieve a darkened color (wet look).

Regardless of the sealer used, it is always important to make sure the tile, stone and grout surfaces are clean and dry before sealer application. **It is also critical to follow product directions completely. Do a test to ensure desired results and call the sealer manufacturer's technical hot line if not sure of choices or options.** Important sealer qualities or characteristics to consider include: level of stain resistance; moisture vapor transmission (especially in exterior areas); UV resistance; freeze-thaw stability; slip resistance; chemical resistance; ease of re-application; longevity and finished look provided.

While most surfaces and installations will benefit from the use of a sealer, it is up to the end user or purchaser to determine the need, suitability and overall value of sealing.

MAINTENANCE

Tile and stone installations are typically easy to maintain with frequent sweeping of dry debris and periodic mopping with a soft-headed mop. Tile, stone and grout surfaces should be maintained on a routine basis using a neutral pH cleaner. Acidic cleaners should never be used for routine cleaning as they can damage the surface of sensitive stones and tiles. Products such as vinegar, bleach, abrasive scouring powders and common grocery store cleaners not recommended for tile and stone can be damaging. While these products can appear to work in the short term, proper maintenance is not only important to maintain the hygienic and aesthetic integrity of the installation, but it also keeps the surface from becoming slippery. For textured or rough surfaces, including recessed grout joints, a periodic heavy-duty cleaning is also recommended, using a high pH (alkaline) cleaner. Always test first in a small area to determine desired results.

PROBLEM SOLVING

Given a proper installation, protection and proper maintenance program, the potential for problems is greatly minimized. However, due to faulty installations, neglected maintenance, acts of Mother Nature and numerous other variables, problems may surface that cannot be remedied through normal maintenance. Contact a reputable manufacturer of care and maintenance products for trouble-shooting remedies, products and procedures.

NOTE: This information is intended and provided as general recommendations guidelines for common industry questions and issues. Read ALL label instructions prior to use and contact the manufacturer as necessary to ensure desired results as actual jobsite conditions may vary.

Care and Maintenance Sealers

Protective below-surface (impregnating) repellents or coatings designed to provide a given degree of stain resistance and reaction time.

Description	Types	Comments
Impregnator/Penetrating Sealer	1. Water-based or solvent-based 2. Economical or premium stain resistance	1. Natural look; no appearance change 2. Do not affect slip resistance as they are below the tile or stone surface. 3. Can be used interior or exterior 4. Longest lasting type of sealer.
Topical or Coating Sealer	1. Water-based or solvent-based 2. Economical or premium stain resistance	1. Will alter the slip resistance to some degree. Check with the sealer manufacturer and or test for desired results. 2. Most recommended for interior use only although some are recommended for exterior use. 3. Require more frequent reapplication than impregnator/penetrating sealers. 4. Low to high gloss finish. 5. Moderate to high degree of darkening or color change.
Color Enhancer Sealer	1. Water-based, solvent-based or 100% solids 2. Economical or premium stain resistance 3. Impregnating/penetrating or topical (lacquer)	1. May or may not alter the slip resistance. Check with manufacturer and or test for desired results. 2. Most recommended for interior use only although some are recommended exterior. 3. Generally provide a high degree of darkening or color change with or without a shine.
Water-based Sealer	1. Impregnator/Penetrating 2. Topical or Coating	1. A sealer that uses water as a carrier. 2. Generally has little to no odor.
Solvent-based Sealer	1. Impregnator/Penetrating 2. Topical or Coating	1. A sealer that utilizes petroleum as a carrier. 2. Generally has strong to low odor.

NOTE: Always test first if possible to ensure desired results are achieved. Read ALL label instructions prior to use. Not all sealers are the same whether they are water-based or solvent-based.

Recommendation for Interior and Exterior Maintenance of Polished Porcelain Tiles

Problem	Cause	Cure
Tile is showing signs of traffic dirt, shoe scuffs, rubber wheels or light stains.	Infrequent or improper cleaning products, process or maintenance program.	Routine maintenance should be conducted using pH neutral cleaning products to clean the installation without adversely affecting the grout or tile surface. Cleaning solution to be properly rinsed with a clean mop head or equipment, wiped dry or wet vacuumed.
Tile is heavily stained and routine maintenance is not improving appearance.	Cleaners are not effective or stains have been trapped in micropores of the surface.	Periodic heavy duty cleaning can be conducted with alkaline, degreasing cleaners to safely break up surface dirt, oils and ongoing wear without adversely affecting the grout or tiles. Professional cleaning may be required for stubborn stains. **NOTE:** A small test should be conducted to determine desired results.

Maintenance of Textured/ Unglazed Porcelain Tiles

Problem	Cause	Cure
Tile is showing signs of traffic dirt, shoe scuffs, rubber wheels or light stains.	The micro-textured surface of an unglazed porcelain tile can attract surface dirt and debris off of shoes as well as carts and/or luggage. Infrequent or improper cleaning products, process or maintenance program.	Use of a penetrating sealer can help to coat the micro textured surface. (Reseal as needed.) Routine maintenance should be conducted using pH neutral cleaning products to clean the installation without adversely affecting the grout or tile surface. Cleaning solution to be properly rinsed with a clean mop head or equipment, wiped dry or wet vacuumed.
Tile is heavily stained and routine maintenance is not improving appearance.	Infrequent or improper cleaning products, process or maintenance program.	When working with textured surfaces it is necessary to adopt a "scrub" maintenance program using soft, nylon brushes along with a degreasing cleaner depending the project conditions. **NOTE:** A small test should be conducted to determine desired results.

SAMPLE LETTER FOR THE TILE CONTRACTOR

Example letter to be used to inform GC or owner regarding the possible need and cost for pre-sealing porcelain tile, especially polished and textured porcelain.

Date

Name
Address
City, State Zip

Re: Project
Use of Porcelain Tiles

Contact:

Porcelain tiles are included in the specification of the above project. Although porcelain tiles have been very successful due to their low maintenance and durability, they are produced with varying characteristics. Certified porcelain, for example, is a much higher quality than some of the low-priced "import versions." Although these tiles may be classified as porcelain they must all be evaluated and addressed individually based on the project usage.

Since not all porcelain tiles are made equally, there are also other factors to be considered. Textured, polished, unpolished and unglazed porcelain tiles, even of the highest quality, must be treated differently. Due to a rough or textured profile, grout pigments can become attached during the grout installation process, thus leaving an unsightly residue or possible staining. Unglazed porcelain tiles (including polished porcelain) may require or benefit from a penetrating sealer prior to grouting. Depending on texture or microtexture of the tile and/or type of grout used, the use of a grout release in addition to – or in lieu of – sealing may be required. This unforeseen cost to remove grout residue from the tile surface and/or grout pigment staining may be prevented by testing the selected porcelain tiles assembled with the grout of choice.

(Contractors name) recommends a test of the materials selected prior to installation. If a test cannot be performed based on time constraints or tile availability, an additional charge of ($0.00 per sq. ft.) will be added to the installation cost for preventive sealing and/or grout-release treatment of the porcelain tiles. As the tile professional, we feel it is our responsibility to make you aware of these potential issues.

If you have any questions or concerns please contact us.

Name and Title
Company

Grout Haze on Textured/ Unglazed Porcelain Tiles

Problem	Cause	Cure
Grout haze on unglazed porcelain tiles.	If grout is not wiped off completely or in a timely manner, a light film may form on the surface. Direct sunlight, high temperatures or wind can dry grout prematurely. Contaminants on tile surface may attract grout. **NOTE:** Small test or story board/ mock up of the project should be conducted to determine desired results prior to installation.	Pre-seal the tiles with a penetrating sealer, coating/finish as a grout release to ease grout clean up. The use of a temporary "film-forming" grout release may also be needed. Tent area from sunlight or wind; work in cooler temperatures during evening hours or early mornings and follow grout manufacturer's installation instructions. To remove haze, use a non-acidic grout haze remover or a manufacturer-recommended scrubbing abrasive compound along with water and a nylon scrub pad. If haze still persists and the grout is cementitious, use a mild acidic cleaner such as sulfamic acid or similar. For ready-to-use pre-mixed grouts, use an alkaline or specialty cleaner as required. For epoxy grouts, the use of a mild solvent-based cleaner or stripper may be required Always test first and consult manufacturer for additional assistance.

Grout Haze on Polished Porcelain Tiles

Problem	Cause	Cure
Grout haze on polished porcelain tiles.	If grout is not wiped off completely or in a timely manner, a light film may form on the surface. Direct sunlight, high temperatures or wind can dry grout prematurely. Contaminants on tile surface may attract grout.	Pre-seal the tiles with a coating/finish as a grout release to ease grout clean up. Tent area from sunlight or wind; work in cooler temperatures during evening hours or early mornings. To remove haze, use a non-acidic grout haze remover or a manufacturer-recommended scrubbing abrasive compound along with water and a nylon scrub pad.
Grout trapped in the surface of a polished porcelain tile.	Polished porcelain tiles may have small pinholes from the polishing process where the grout can become trapped.	Pre-seal the tiles with a penetrating sealer to coat pores and ease grout clean up. Grout removal may not be possible. **NOTE:** Small test or story board/ mockup of the project should be conducted to determine desired results.

Care and Maintenance Myths and Helpful Hints

Myth/Question	Answer
Q: Is bleach and a toothbrush the only way to get grout clean?	A: False. With the exception of epoxy and single component or pre-mixed grouts, using a sealer will make cleaning your grout easy with neutral pH cleaner or specialty grout cleaner and the proper cleaning procedure. Bleach can be damaging to grout and to the sealer in the grout over time.
Q: Is vinegar a good cleaner for my tile or stone installation?	A: Vinegar is a mild acid. Acids do not degrease and primarily work by attacking the minerals in the grout and many stones thereby creating damage overtime. Vinegar can also compromise the sealer in the tile, stone or grout. A neutral pH or specialty tile or stone cleaner should be used.
Q: Are Windex or 409 good for cleaning my granite countertop?	A: While these products do clean, they can be damaging with regular use. Many granites today are treated with a resin that can become cloudy or discolor with the repeated use of these types of cleaners. A neutral pH or specialty stone cleaner is recommended for routine cleaning.
Q: Can I clean my tile or stone with lemon oil to bring it back to life?	A: Lemon oil or cleaners containing oil will darken and appear to rejuvenate the appearance of tile or stone. However this effect is temporary and often they leave behind residues that remain tacky and serve as dirt and dust collectors. A neutral pH or specialty tile or stone cleaner is recommended for routine cleaning. For certain tiles or stones, a color-enhancing sealer can be used to darken and highlight the character.
Q: Is muriatic acid the best product to remove grout haze or efflorescence on my tile or stone?	A: Muriatic acid should never be used on tile installations. While acids do breakdown and dissolve mineral-based contaminants such as efflorescence and grout haze, this type of acid is too strong and has been known to damage tile, stone and grout. It is also very hazardous to work with and when used indoors can corrode metal fixtures. Milder acids such as sulfamic, phosphoric or organic acids are very effective and much safer.
Q: Does grout really need to be sealed?	A: All cementitious grout, unless otherwise stated in the technical data sheet, is porous and subject to staining if not properly sealed. Sealing also reduces the ongoing maintenance requirements and helps preserve the original look.
Q: Do you really need to wait two to four weeks before using a sealer once the tile or stone is installed?	A: Some sealers can be applied within days of grouting. These products allow for good vapor transmission so the concern of trapping moisture in is no longer a barrier. There are some sealers that can be used the same day of grouting due to good vapor transmission and specific technology that allows the sealer to penetrate wet grout. There are also grout sealer additives that can be mixed with the grout in place of using a sealer post installation. Always check with the manufacturer of any grout sealer for their specific recommendations and limitations.
Q: Does sealing my tile, stone or grout stop it from getting dirty?	A: No. Sealers are designed to provide a given degree of stain resistance and reaction time. Tile and stone are inherently low-maintenance surfaces. Sealing can help further lower the overall maintenance requirements. However they do not provide a maintenance system and should be cleaned with mild pH neutral cleaners designed for tile, stone and grout for routine maintenance. This will also help ensure the ongoing function and life of the sealer itself.

Care and Maintenance Problem Solving

Problem	Correction
Grout haze (cement or latex modified)	Non-acidic grout haze remover (within first 10 days of grouting). Sulfamic acid or phosphoric acid cleaners (after new grout has cured at least 10 days).
Grout haze on acid-sensitive surfaces (such as marble or metallic glazes)	Poultice and water slurry scrub.
Epoxy grout haze	Non-flammable solvent strippers or epoxy grout haze removers.
Sealer residue and or stripping sealer	Non-flammable solvent strippers or contact sealer manufacturing for recommendations.
Removal of old or worn wax-type coatings	Alkaline cleaners
Deep-set stains in porous tile, grout or stone	Non-flammable solvent strippers or poultice
Faded or uneven grout color	Color enhancer sealers or grout colorants.
Efflorescence/hard water deposits	Sulfamic acid, phosphoric acid or specialty efflorescence treatment products.
Soap scum	Alkaline cleaners
Adhesive/Mastic residue	Non-flammable solvent strippers.
Repolishing and or maintaining polished marble, limestone or travertine	Polishing powders/compounds or recrystallization products. Heavily worn or damaged floors may require professional restoration and resurfacing.
Honing travertine, limestone and marble	Honing powders or liquids
Shaded grout color	Grout colorant
New installation – Uniform color, grout is too light	Color enhancer
New installation – Blotchy color, grout is too light	Grout colorant

NOTE: The above information is intended and provided as general recommendations guidelines for common industry questions and issues. Read ALL label instructions prior to use and contact the manufacturer as necessary to ensure desired results as actual jobsite conditions may vary.

Photo courtesy of Walker Zanger

Care and Maintenance Glossary

Acidic Cleaners: Acids and cleaners containing acid have a low pH of 1 to 6. They can best be described as problem solvers and clean primarily by chemically attacking any surfaces with exposed minerals. Acids, especially stronger acids such as muriatic, can be very damaging to grout, metallic glazes and stone containing calcium, such as marble. Muriatic acids used to clean any Portland cement material will continue to work on Portland cement products unless thoroughly rinsed. Muriatic acid can attack metals when used in an enclosed area without proper ventilation. This is an important safety concern – muriatic acid in combination with chlorine cleaners can be extremely dangerous.

Weaker acids such as phosphoric, sulfamic and organic acids are recommended for removal of cementitious grout film and hard water deposits. Muriatic acid should never be used on tile and stone installations.

Alkaline Cleaner: A cleaner that has a high pH of 8 to 14. These alkaline or "base" cleaners have stronger degreasing capabilities for heavy-duty cleaning, yet are still considered safe for use on tile, most stone and grout.

Coating or Topical Sealer: A sealer designed to form a protective film on the surface, which will result in a low, medium or high sheen finish.

Color-Enhancing Sealer: A sealer designed for porous stone to provide a wet-look or darkened appearance. May be penetrating or topical coating.

Efflorescence Removers: Non-acidic or acidic liquids designed to remove soluble salts that occur as the result of moisture reacting with soluble minerals that are often present in the soil and cement.

Floor Finish: A synthetic liquid wax designed to add a protective sheen coating over sealed hard surfaces.

Grout Colorant: A pigmented paint-like liquid designed to recolor and provide a degree of stain protection to existing grout.

Grout Film Removers: Non-acidic versions are used to remove grout haze during the first few days after grouting when an acid-based remover may be potentially damaging to the new grout. Mild, acidic versions are designed to remove grout film after full grout cure.

Grout Sealer: A sealer formulated primarily for use on porous cementitious sanded and non-sanded grout.

Honing: A process designed to turn a polished or rough stone surface into a smooth, non-reflective surface. Most commonly used for calcium based stones such as marble, limestone and travertine. This can be done mechanically, usually with diamond pads, or chemically with abrasive powders or liquids normally containing mild acids.

Neutral Cleaner: A cleaner that has a neutral pH, usually defined as 6-1/2 to 7-1/2 on the pH scale. Neutral pH is considered the safest type cleaner for routine cleaning of tile, stone and grout.

Paste Wax: A natural or synthetic paste that provides the same function as a floor finish.

Penetrating or Impregnator Sealer: A sealer designed to penetrate into a porous surface, leaving no visible sealer or coating on the surface. May or may not change the appearance of the tile, stone or grout it is applied to.

Poultice: A powder or paste designed to pull stains from porous tile, stone and grout substrates. Some are also recommended to be used in conjunction with cleaners to increase the cleaning capability and results.

Pre-Grouting Sealing: The process of applying a "grout release" or an application of the primary sealer that will be applied to the finished installation. This pre-sealing procedure is designed to provide protection from grout pigment staining during the grouting process. A secondary benefit is to ease the grout cleanup process.

Re-Crystallization: Normally referred to as a process where a worn marble or other stone containing calcium is re-polished with the use of a low RPM (175 – 350 RPM) polishing machine and steel wool pad, creating heat along with a liquid, normally containing an acid blend. This resultant combination of heat and chemical creates a chemical reaction with the surface layer of the stone resulting in a renewed polish. This process is often used in commercial areas to maintain polished calcium-based stones such as marble, limestone and travertine installations.

Sealer: Liquid substance applied to porous tile, stone, grout, or concrete surface designed to provide a degree of water repellency and or stain protection. May be penetrating or topical coating. Sealed surfaces may stain under certain circumstances even if sealed.

Solvent-based Sealer: A sealer utilizing a petroleum-based carrier.

Strippers: A term usually referred to as a liquid substance designed to remove existing sealers, mastic and epoxy grout haze. Many strippers contain strong solvents, may be flammable, and should be used with great caution and care.

Water-based Sealer: A sealer utilizing water as a carrier.

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PRECAUTIONS

Photo courtesy of Schluter Systems

Photo courtesy of Lambert Tile and Stone
2023 NTCA Five-Star Project of the Year
Residential Grand Prize winner

Chapter 11
Precautions

Coefficient of Friction and the DCOF AcuTest®

Coefficient of friction (COF) is the measurement of a tile's frictional resistance, closely related to traction and slipperiness. The method for measuring the COF of ceramic tile floors changed in 2012, after years of research and with the approval of the accredited national consensus body (ASC A108) responsible for ANSI A137.1, the American National Standard Specifications for Ceramic Tile. Previously, COF was determined per the ASTM C1028 method from a measurement of static friction, which is the frictional resistance one pushes against when starting in motion. The new method, known as the DCOF AcuTest®*, measures dynamic friction, which is the frictional resistance one pushes against when already in motion. For both static coefficient of friction (SCOF) and dynamic coefficient of friction (DCOF), a slip occurs when pushing off with more force than the surface can resist.

In addition to mandating the switch from SCOF to DCOF, the standard now requires a minimum wet DCOF AcuTest value of 0.42 for ceramic tiles for level interior spaces expected to be walked upon when wet. According to the standard, tiles with a wet DCOF AcuTest value of less than 0.42 are only suitable for floor areas that will be kept dry. Polished tiles generally fall into this category.

Previously, there was no required value in ANSI A137.1 for wet floors (static or dynamic), although a minimum value of 0.6 wet SCOF, measured by ASTM C1028, was commonly specified for ceramic tile in commercial spaces for many years. The new required value stems from extensive research in Europe and at TCNA. Researchers at the University of Wuppertal in Germany studied human subjects walking on force plates to find the relationship between the tangential force and the vertical force needed for reliable traction (this relationship defines the coefficient of friction and has been widely studied in the U.S. and in Europe). They then considered many different slippery conditions, different ways people could move on a surface, and accident statistics over many years to recommend to the German national insurance body a minimum wet DCOF value of 0.42 for flooring.[1]

In various studies at TCNA, including a study of over 300 tile surfaces[2], TCNA researchers found that 0.60 wet SCOF could be correlated on average with 0.38 wet DCOF.

Considering both the TCNA research and the years of research in Europe, the ANSI A108 Accredited Standards Committee decided to include an additional measure of safety over the widely used ASTM C1028 wet SCOF value of 0.60. They revised ANSI A137.1 to include a threshold minimum wet DCOF AcuTest value of 0.42 for level interior spaces expected to be walked upon when wet.

Not all tiles, though, with a wet DCOF AcuTest value equal to or greater than 0.42 are suitable for all level interior spaces. The specifier shall determine tiles appropriate for specific project conditions, considering by way of example, but not in limitation, type of use, traffic, drainage, how the tiles are profiled or structured, expected contaminants, expected maintenance, expected wear, and manufacturers' guidelines and recommendations.

Refer to Section 6.2.2.1.10 of ANSI A137.1 for further explanation and detail.

*DCOF AcuTest is the industry designation for the test procedure contained in ANSI A137.1 Section 9.6, which has been extensively researched, allows for in-situ field measurements, and is in use at tile manufacturing facilities. It was so named to distinguish it from other DCOF measurements using different instruments and/or protocols.

[1]The German research considered was extensive and can be found in the following publications: (1) Boenig, Stefan. Experimental Investigation to Determine the Standardized Limits of the Coefficient of Friction When Walking (Archive Number D468), University of Wuppertal Department of Safety Technology, 1996. (2) Skiba, Reinald. (1988). Sicherheitsgrenzwerte zur Vermeidung des Ausgleitens auf Fuessboeden, Zeitschrift fuer Arbeitswissenschaft (Journal of Occupational Science), 42, 47-51. (3) BGI/GUV-I 8687, 2011, "Bewertung der Rutschgefahr unter Betriebsbedingunen," German National Institute for Social Accident Insurance (DGUV). (4) Sebald, Jens. (2009). System oriented concept for testing and assessment of the slip resistance of safety, protective and occupational footwear. Berlin: Pro BUSINESS GmbH.

[2]While the 300 surfaces chosen were selected to represent a wide spectrum of tile surfaces, no claim is made or offered that this represented the entire spectrum of available tile surfaces nor can any inference be made regarding any individual tile surface. ASTM C1028 SCOF measurements and DCOF AcuTest® measurements cannot be directly compared or correlated on a per tile basis as different sensors, test conditions, and measurement physics are employed.

How Sealers, Treatments and Cleaning Products Can Alter the Dynamic of Coefficient of Friction (DCOF) of Floor Tile

EFFECT OF SEALERS/TREATMENTS ON DCOF FOR TILE WALKING SURFACES (FLOORS)
Tile is one of the most durable, timeless and functional surface materials that can be installed. It is used for both floor and wall applications in both commercial and residential applications and often used for wet areas such as showers, pool decks, etc. Its aesthetic options are highly varied as well including both glazed and unglazed formats. Given the diversity of use, function and appearance, not all tiles are created equal nor designed for all applications. This letter is designed specifically to address those tiles used on floor installations.

While glazed porcelain tile requires no sealer/treatment, some manufacturers are applying nano sealers or topical waxes/sealers at the factory prior to shipment for some polished and even some unpolished porcelain (through-body) tile. Other manufacturers are recommending that a penetrating/impregnator sealer be applied to these tiles prior to or after installation. This is done or recommended for several reasons based on the manufacturer and tile (series) they produce:

- Protective treatment for shipment/transportation
- Act as grout release prior to grouting; especially where a contrasting grout color will be used
- Seal the tile from various contaminants such as coffee, oils, food, etc.

While some of these are meant to be removed after installation, others are meant for more long term use and benefit. Topical waxes/treatments will certainly alter the natural slip resistance of the tile while most penetrating/impregnator sealers will not, as by their nature, they are absorbed into the existing porosity of particular tile and any excess is wiped/buffed off per manufacturer's directions.

The manufacturer of the treatment could be asked to provide the DCOF test results with any applied or recommended sealers, waxes or treatments to the requesting party.

Some of the concerns when applying a Sealer/Treatment to floor tile are:
- May show wear patterns (if topical or a surface sealer/finish is used)
- May alter the DCOF (if topical or a surface sealer/finish is used)
- May peel off over time if tile is non-porous and sealer does not penetrate tile (if topical or a surface sealer/finish is used)
- Could attract dirt since sealer will be sitting on top (if topical or a surface sealer/finish is used and or if a penetrating/impregnator sealer is misapplied)

Care should be taken when applying a treatment of any kind to the manufactured tile you are using. With the exception of polished porcelain, where in almost every case the tile manufacturer would require sealing prior to grouting, the above mentioned problems could result. It is important to consult the manufacturer of the surface sealer/treatment product you are using to:
a) Make sure it is designed for the type of tile you are using.
b) Thoroughly clean the tile surface of any contaminants prior to application of any surface treatment products.
c) Following manufacturer's instructions for application is critical as improper application of certain products that otherwise would not affect DCOF may adversely change the natural slip resistance.

EFFECTS ON WARRANTY
Tile manufacturers offer a warranty that the tile is free of manufacturing defects in accordance with recognized standards (ISO or ANSI). While applying any kind of treatment to the tile most likely will not void the tile manufacturer's warranty for physical characteristics like breaking strength or dimensional characteristics, altering the surface will change the dialogue with the tile manufacturer in respect to cleaning, maintenance, stain resistance, gloss, and other surface characteristics that would be altered by a surface treatment. Most importantly, the DCOF of the tile as reported by the tile manufacturer will no longer be applicable, and the liability for any claims made for slip/fall will reside with the user who has applied the surface treatment.

Stone in Wet Areas

Stone installed in wet areas may experience discoloration. In some cases, the cause, prevention or correction of the discoloration is unknown.

Refer to installation recommendations and documentation from the manufacturer on intended use.

See photo examples of stone discoloration in a wet area.

Tile Over Other Surfacing Materials – *TCNA Handbook* Method TR711 (Asbestos Fiber Warning)

WARNING: Do not sand existing resilient flooring. Certain older resilient floor coverings, including sheet vinyl floor covering and vinyl tile, may contain asbestos fibers that are not readily identifiable. Inhalation of asbestos dust may cause serious bodily harm. Smoking greatly increases any such risk of serious bodily harm.

Tile Over Other Surfaces

Installing new tile over other surfacing materials/walls and floors is an approved industry method.

The following methods are contained in the *TCNA Handbook*:
TR711-with organic adhesive, interiors only
TR711-with cementitious bond coat, interior and exterior
TR711-with tile-setting epoxy mortar, epoxy adhesive or modified epoxy emulsion mortar
TR712-tile over tile interior floors
TR713-tile over tile interior walls

These various surfaces must be checked for structural deficiencies, bonding capabilities, and flatness.

- Existing tile may be a suitable substrate to install new tile; the benefits of installing new ceramic tile over existing tile include cost savings of not having to remove the existing tile and substrate and saving time by being able to install tile on a flat substrate.
- There are manufacturer specific primers that can be applied to existing tiles so that mechanical or chemical scarifying is not needed. However, check with the specific manufacturer to understand the cleaning and preparation requirements before installing these primers.
- Please note scarification can cause small particles to be released; these particles could cause harm if swallowed or inhaled. Proper safety equipment should be worn/used at all times.
- When installing tile over old concrete floors, these floors should be tested for any type of existing bond breakers. Example: old kitchen floors that have oil or grease on them. Check with the mortar manufacturer to see if these bond breakers can be neutralized.

Photo courtesy of the National Tile Contractors Regional Training Program

Spot Bonding

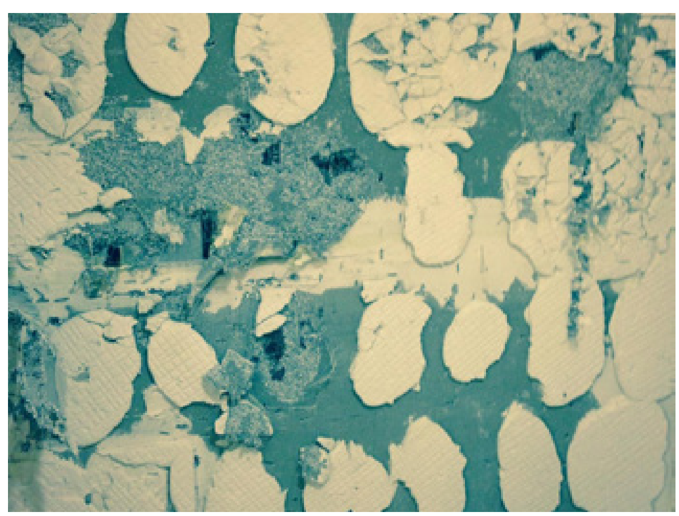
INTRODUCTION
The popularity of large size ceramic and stone products, in many different formats and thicknesses, coupled with the increasing desire for smaller grout joints, brings increasing challenges to the installation community. Achieving durable and aesthetically pleasing installations of large tile requires greater knowledge of and adherence to standards by both the substrate and tile trades. This is often contrary to the perspective of the designer, specifier or end user who wrongly perceives fewer tile and smaller grout joints means the installation is less difficult. When the faulty perception of less or easier work is combined with accelerated construction schedules and tight budgets, unrealistic expectations often occur. The tile contractor often finds themselves under pressure to find a means of accelerating the installation schedule while still achieving a profit. This often leads the installer to employ the ill advised practice of spot bonding.

THE ISSUE
Historically floor and wall surface tolerance recommendations were 1/4" in 10' with no more than a 1/16" variation in 12". This worked well when tiles were smaller and the grout joint was commonly around 1/4". However, that particular substrate recommendation often proves inadequate when using larger size tiles, such as those with any one side being 15" or more. Industry trends continue to include tiles in larger formats, in varying thicknesses and multiple size patterns with minimal grout width requirements. To address this, the ANSI and *TCNA Handbook* Committees adopted new substrate recommendations for tile with a leading edge of 15" or greater that calls for 1/8" in 10' with no greater than 1/16" variation in 24".

Narrow grout joints on large tile compound the need for floor flatness. The stringent tolerances under the ANSI revision are often beyond the technical capabilities of the typical concrete contractor. It then falls to the tile contractor to provide a suitable substrate for this product. Remediating the substrate to meet the tolerance requirements should be addressed by providing an appropriate allowance in the specification process; however, this is often ignored. This financial dilemma often leads to the practice of spot bonding where dollops of mortar are used in lieu of an appropriate floor filler material, such as patches, mortar beds or self-leveling underlayments. This practice is done often in both wall and floor tile applications.

INDUSTRY COVERAGE REQUIREMENTS
The current mortar coverage standards have a lengthy history of providing long lasting serviceable tile installations. Spot bonding with mortar will not meet coverage requirements and will put the tile contractor at risk if a job failure occurs. Spot bonding has been reviewed and considered on a number of occasions in the past. Currently, the only approved method for spot bonding under the *TCNA Handbook* is W260, which is recommended for walls in interior dry areas only, using a suitable bonding epoxy. There are no methods or standards that recognize spot bonding thinset mortar for either floor or wall tile installations.

Spot bonding, whether used in conjunction with fully troweling the floor prior to applying the dollops or spots; or as is happening in increasingly alarming circumstances, when the spots are simply applied directly to the substrate without keying in the mortar or troweling it in, rarely provides the coverage required by manufacturer's recommendations and industry standards. It is also in conflict with the design of the products as defined under ANSI A118 thinset standards, which state "dryset mortars are designed as direct bond adhesives and not intended for truing or leveling substrates or the work of others." Additionally, spot bonding does not provide coverage as required under ANSI A108.5, which states "average contact area shall be not less than 80% except on exterior or shower installations where contact area shall be 95% when not less than three tiles or tile assemblies are removed for inspection."



Spot bonding does not provide coverage as required under ANSI A108.5.

Spot Bonding (continued)

THE PROBLEM

Ceramic tile is not considered a structural product until it reaches a thickness of 1-1/4". As a thin clay surfacing unit, ceramic tile must be fully supported. On a purely technical basis, spot bonding affects the tile installation negatively in numerous other ways.

- Limited impact resistance – Other than those areas supported by mortar dollops, impact resistance is limited to that of the tile product. Such loads are typically only several hundred pounds of force rather than in excess of 2,000 pounds force when the tile is fully supported by thinset and the substrate.
- Limited load resistance – Values are similarly reduced under wheel loads that are not uncommon in residential applications and typical in commercial installations.
- Product design limitations – Dollops applied in varying thicknesses likely exceed the design limitations of the product and could result in excessive shrinkage, causing bonding loss.
- Shear Bond – Spot bonding greatly reduces the shear bond value of the tile to thinset interface. Subjecting spot bonded tile to curvature related tensile stress, moisture expansion, and thermal expansion and contraction can cause bond loss.
- Grout – Side support for the tile, vital to longevity of the installation, cannot be properly provided when a large part of the tile body is suspended from the substrate by mortar dollops.
- Moisture – When used in wet areas such as showers and steam showers, voids in the mortar application provide a reservoir for the accumulation of moisture. Wet walls will retain water and in horizontal on grade applications moisture will condense on the underside of the tile and water will pool in the voids, causing degradation and/or maintenance issues

CONCLUSION

In addition to the numerous reasons cited in this position statement that address the technical reasons spot bonding is not recommended, there are legal issues to consider as well. If there is a specification on the project you are working on, you are legally obligated to follow the specification. Not following the contract you signed may serve as a basis for rejection of your work. Safety considerations also must be taken into account. We are seeing an increasing number of wall tile installations, including exterior facades, utilizing spot bonding methods and materials. If tile is not bonded appropriately and falls off of the walls, the safety of anyone in the vicinity is at risk, and the legal implications to the tile contractor could be disastrous.

Unfortunately, spot bonding in order to avoid lippage in the tile installation is increasing in the field, creating additional failures and posing a risk to industry growth. The National Tile Contractors Association strongly urges our members to properly train their installers, crews, and superintendents to not let this practice take place on your projects. We urge our members to become familiar with the subsurface tolerance requirements for the tile specified on the project, and to proactively address this issue in the bid process, or at a minimum prior to starting the work in the field.

If tile is not bonded appropriately and falls off of the walls, the safety of anyone in the vicinity is at risk, and the legal implications to the tile contractor could be disastrous.

Use of Felt and Similar Products as Crack-Isolation Membrane

Various types of paper or sheet vinyl are occasionally used in certain geographical areas of the country and promoted as a crack-isolation membrane. Use of roofing felt, sheet vinyl, scribing paper, or scrim reinforced kraft paper glued or unglued to both concrete slabs and over wood construction have a long history of failure. None of the testing done thus far on roofing felt, scribing paper, sheet vinyl or scrim reinforced kraft paper and similar products has met all the requirements of the ANSI A118.12 Crack-Isolation Membranes for Thin-set Ceramic Tile and Dimension Stone products. Additionally, there are currently no product or applications of this type recommended for such use under current ASTM standards. As such, representation for suitability of use and installation would then lie solely with the individual manufacturer or installer. These products typically lack the performance features and criteria that would allow effective control of fractures without transmission through the finished tile surface. Despite their shortcomings these products continue to be used in a guise of being beneficial to the consumer while having a long history of poor performance. The initial financial savings realized by using such an inferior method or product often results in a huge replacement cost to the unsuspecting end user at a later date well after any warranty period.

There are numerous membrane systems available that meet the current industry standards listed under ANSI A118.12 Crack-Isolation Membranes for Thin-Set Ceramic Tile and Dimension Stone products. Products meeting these strict performance requirements provide warranted crack-isolation.

There are numerous membrane systems available that meet the current industry standards. Products meeting these strict performance requirements provide warranted crack-isolation.

Optical Hazing Possibly Caused by Post-Fire Organic Coatings and/or Polishing Inconsistencies

On occasion, inconsistencies in the reflective properties of polished tile surfaces have been observed. Sometimes called optical hazing, this distortion can be invisible under normal lighting and only noticeable when illuminated by light coming in from the side at a low angle. A variety of inconsistencies have been reported, including light-colored cloudy spots, dark shadow spots, dark shadow ribbons that run across the entire tile, wavy regions of inconsistent reflectivity, and fuzzy spots or distorted lines in a reflected image. **Unfortunately, these conditions are discovered most often after tile has been installed and in service. They are commonly thought to be a result of grout haze or traffic stains.**

There are at least two broad possible causes of optical hazing: 1) the presence and/or partial removal of certain post-fire organic coatings, and 2) inconsistencies in the materials being polished or in the polishing process itself.

With regards to post-fire organic coatings, there are different types that serve different purposes. Most are of a wax-like consistency, and several are described as "nano-coatings" (which may or may not contain nano-sized particles). Some coatings are intended solely to protect polished products from scratches during handling and installation, some are intended to increase luster, some are intended to improve stain resistance of products that weren't fully vitrified prior to polishing or that, while vitrified, have open micro-pores from the polishing process, and some are intended for a combination of the above.
If optical hazing is observed and post-fire organic coatings are contributing to the problem, the coating may be uneven and refracting light waves in a non-uniform manner, the coating may have been scratched, buffed, or partially removed due to the installation process or normal wear, or foreign material may have been encapsulated in the coating. There are no standards for the nomenclature, performance or handling of post-fire organic coatings. Although some tile distributors caution purchasers with notice of coatings, **most distributors are unaware that they were applied**; if it is intended to be removed; how it can be removed; and recommended installation and maintenance for coatings that are intended to be permanent.

With regards to polishing inconsistencies, many factories have developed proprietary procedures to produce uniformly consistent high quality polished surfaces using sliding head polishing machines. Such machines incorporate a transverse oscillating motion to increase overall uniformity. The overall quality of a polished product is dependent on several factors, including polishing technology (e.g. static head vs. sliding head), polishing compounds, maintenance of the polishing machines, and the characteristics of the material being polished.

While post-fire organic coatings and polishing are two separate issues, both may be relevant to optical hazing. As is the case in many other situations involving product aesthetics and consumer expectations, there are no standards for luster or the final reflectivity of polished products. Experience with manufacturers' products is a useful guide whenever there are no standards on which to rely.

Purchasers are strongly encouraged to speak with the manufacturers and distributors of the products they are considering and carefully examine polished products for overall quality, consistency, and the presence of post-fire organic coatings. Purchasers are also encouraged to consult with their suppliers where polishing quality is unacceptable or when post-fire organic coatings are present regarding their maintenance or removal if appropriate.

While post-fire organic coatings and polishing are two separate issues, both may be relevant to optical hazing.

[1] 2015 Tile Council of North America, Inc. Handbook for Ceramic, Glass and Stone Tile Installation

Linear Drains Checklist

WHY A LINEAR DRAIN?

- They provide solutions for ADA-compliant showers.
- Allows large-format tiles to be installed in a shower with one single pitch to drain.
- Ideal for barrier-free applications due to drainage capacities.
- These drain systems are the easiest to access and maintain.

1. **PRE-PLUMBING** – the most important step
   - Planning and coordination between GC, plumber and tile professional will ensure successful project.
   - System should be code compliant.
   - Read and follow manufacturer instructions on the entire installation.
   - Is the slab or wood structure lowered or dropped to accommodate linear drain?
   - Is the shower going to include a curb or be a curbless shower?
   - How is plumbing prepared? Is the pipe in the right location for the drain outlet?
   - Type of connections, hub or no hub and/or clamping ring.
   - You should not use offsets in plumbing if the location is not correct.
   - If there is a wall drain, is the wall prepared for the installation?
   - What type of shower pan is being installed? (preformed, mortar bed, etc.)
   - A complete linear drain system is advised (drain and waterproofing system).
   - Drains that require fabrication in the field are not advised due to liability issues.
   - Drains that have pre-pitched bodies are suggested.
   - Drain covers should be chosen on their ability to properly evacuate water in the shower.

2. **PLUMBING**
   - Is the plumbing in the correct position for the no hub connection?
   - Is the right dimension away from the wall for the connection?
   - Does the pipe need to be cut off for the no hub?
   - The plumber will be making the drain to waste line connection.
   - Always dry-fit connections before final assembly.
   - Can the drain to waste line connection be made after the installation or does it need to be made during installation?

3. **INSTALLATION OF DRAIN**
   - Follow manufacturer's instruction.
   - Is the no hub tightened properly?
   - Is the drain installed at the proper height?
   - Is it level from side to side?
   - There may be the need for temporary bracing of the drain in the installation.
   - This will ensure proper height and depth. Make sure drain is level.
   - Has mortar been installed under the drain to keep it tight and secured?
   - Required slope of mortar bed to follow IAPMO and ANSI specification of slope being no less than 1/4" per ft and no more than 1/2" per ft.

4. **WATERPROOFING**
   - Be sure the drain is supported to prevent deflection in the drain body.
   - Wrap the waterproofing up the walls with inside and outside corners as needed.
   - What type of waterproofing membrane is being used (liquid applied, sheet, trowel applied, etc.)?
   - Make sure your waterproofing is connected to the drain correctly.
   - Water test before installing tile.

5. **INSTALLATION OF TILE**
   - During the installation protect the waterproofing from damage.
   - Make sure the location of the grate is done properly for distance. This includes the tile being installed parallel to each side.
   - Make sure you have the correct elevation with your tile in relationship to grate.
   - Clean out all grout and thin set where grate will be installed.

6. **INSTALLATION OF GRATE**
   - Clean tile and drain assembly for grate installation.
   - Install spacers or height adjusters for proper seating of grate if needed.
   - Follow manufacturer's directions for finishing and securing grate.
   - Consider the possibility of edge profiles to finish rough tile edges.

Stone, Ceramic, Glass Tile Inspection Check List

The following procedures are used to visually inspect ceramic/stone/glass tile work after tile has been installed.

INDUSTRY STANDARDS REFERENCE

- American National Standards Institute (ANSI A108 Series) Installation Standards
- American National Standards Institute (ANSI A137.1 Manufacture standards for ceramic tile Tables 6-10).
- American National Standards Institute (ANSI A137.2 Manufacture standards for glass tile tables 5, 6, 7.
- Tile Council of North America Inc. (TCNA) Details & Guidelines for Ceramic, Glass, Stone tile installations (applicable publication for year of installation).
- Natural Stone Institute (NSI) Dimension Stone Design Manual (applicable publication for year of installation).

INSPECTION PROCEDURES

Light Source: Artificial permanent and natural light, without glare or grazing type lighting. Use of graze, wall-washer and cove-type lighting, where the lights are located either at the wall/ceiling interface, or mounted directly on the wall, are popular techniques for producing dramatic room lighting effects. When proper backing surfaces, installation materials and methods, and location of light fixtures are not carefully coordinated, these lighting techniques may produce shadows and undesirable effect with ceramic, glass and stone tiles. Similar shadows are created from side lighting interior walls and floors when light shines at that angle through windows and doors.

Refer to "Critical Lighting Effect" in the *NTCA Reference Manual* for pictures.

Refer to ANSI A108.02.4.3 Workmanship, cutting fitting and grout joint size.

- Viewing position: 36" from walls and 60" from floors
- Viewing time for visual defects: 15 seconds each wall elevation, floor area, ceiling and counters per room. For rooms with floor area larger than 200 square feet adjust time accordingly.
- Lippage is allowed by the standards, calculated by, tile tolerances such as facial dimensions, thickness, and edge or diagonal warpage. Refer to ANSI A137.1 tables 6-10 for Ceramic Tile, refer to ANSI A137.2 tables 3, 5, 6, 7 for Glass Tile.
- Grout joint: Joints should be reasonable consistent. Note, when large format or rustic tiles and patterns are selected, the grout joint must be increased to accommodate size tolerances in the tile and pattern. Refer to ANSI A108.02.4.3.8.

Shade variation in tile, stone and grout is inherent in all installations.

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GLOSSARY

Tile Glossary

Abrams law
A rule stating that with given concrete materials and conditions of test the ratio of the amount of water to the amount of the cement in the mixture determines the strength of the concrete, provided the mixture is of a workable consistency. (See also Water cement ratio).

Abrasion
Wearing away by friction.

Abrasion resistance
Ability of a surface to resist being worn away by rubbing and friction.

Absorbed moisture
Moisture that has entered a solid material by absorption and has physical properties not substantially different from ordinary water at the same temperature and pressure. (See also Absorption.)

Absorption
The relationship of the weight of the water absorbed by a ceramic specimen subjected to prescribed immersion procedure, to the weight of the dry specimen, expressed in percent. (ASTM C242).

Accelerator
A substance that, when added to concrete, mortar, or grout, increases the rate of hydration of the hydraulic cement, shortens the time of setting, or increases the rate of hardening of strength development, or both.

Accessories (Tile Accessories)
Ceramic or non-ceramic articles, affixed to or inserted in tile work, as exemplified by towel bars, paper, soap and tumbler holders, grab bars and the like.

Acid
A chemical substance usually corrosive to common metals (iron, aluminum, zinc) and that, in water solution, imparts an acid, sour or tart taste. Acids are generally divided into two classes: (a) strong mineral or inorganic acids such as sulfamic, sulfuric, phosphoric, hydrochloric or nitric, (b) weak organic or natural acids such as acetic (vinegar), citric (citrus fruit juices), oxalic, and fatty acids (oleic, palmitic, stearic, etc.)

Acid and alkali-resistant grout
A grout that resists the effect of prolonged contact with acids and alkalis.

Acidity
A general term applying to substances on the acid side of neutral - principally the degree of acidity.

Acrylic
A general class of resinous polymers derived from esters, amides or other acrylic acid derivatives.

Additive
A term frequently (but improperly) used as a synonym for addition or admixture.

Adhesion
The state in which two surfaces are held together by interfacial forces that may consist of valence forces or interlocking action, or both. (See also Adhesion, mechanical and Adhesion, specific.)

Adhesion, mechanical
Adhesion between surfaces in which the adhesive holds the parts together by interlocking action. (See also Adhesion, specific.)

Adhesion, specific
Adhesion between surfaces that are held together by valence forces of the same type as those that give rise to cohesion. (See also Adhesion, mechanical.)

Adhesive
A substance capable of holding materials together by surface attachment. Note: Adhesive is the general term and includes, among others, cement, glue, mucilage and paste. All of these terms are loosely used interchangeably. Various descriptive adjectives are applied to the term adhesive to indicate certain characteristics as follows: (a) Physical form, that, is liquid adhesive, tape adhesive, (b) Chemical type, that is, silicate adhesive, resin adhesive, (c) Materials bonded, that is, paper adhesive, metal-plastic adhesive, can label adhesive, (d) Conditions of use, that is, hot-setting adhesive.

Adhesive, ceramic
Used for bonding tile to a surface. Rubber solvents; and rubber and resin-based emulsions can be used as adhesives.

Adhesive, tile
Organic adhesive used for bonding tile to a surface. Rubber solvents and resin-based and rubber emulsions can be used as adhesives.

Adhesive, pressure-sensitive
An adhesive made so as to adhere to a surface at room temperature by briefly applied pressure alone.

Adhesive, solvent
An adhesive having a volatile organic liquid as a vehicle. Note: This term excludes water based adhesives.

Admixture
A material other than water, aggregates, and hydraulic cement, used as an ingredient of concrete or mortar, and added to the concrete immediately before or during its mixing.

Adobe
Unburnt brick dried in the sun.

Aggregate
Granular material, such as sand, gravel, crushed stone, and iron blast-furnace slag, used with a cementing medium to form a hydraulic-cement, concrete or mortar. (See also Aggregate, heavyweight and Aggregate, lightweight.)

Aggregate, heavyweight
Aggregate, of high specific gravity such as barite, magnetite, limonite, ilmenite, iron or steel used to produce heavy concrete.

Aggregate, lightweight
Aggregate, of low specific gravity, such as expanded or sintered clay, shale, slate, diatomaceous shale, perlite, vermiculite, or slag; natural pumice, scoria, volcanic cinders, tuff, and diatomite; sintered fly ash or industrial cinders; used to produce lightweight concrete.

Air, entrained
See Entrained air.

Air-entraining
The capability of a material or process to develop a system of minute bubbles of air in cement, mortar, or concrete during mixing.

Air-slack
A condition where soft-body clay, after absorbing moisture and being exposed to the atmosphere, will spall a piece of clay and/or glaze.

Alkali
A chemical substance that effectively neutralizes acid material so as to form neutral salts. A base. The opposite of acid. Examples are ammonia and caustic soda.

Alumina porcelain
A vitreous ceramic whiteware for technical application in which alumina (A1203) is the essential crystalline phase. (ASTM C242).

Alumina whiteware
Any ceramic whiteware in which alumina (A1203) is the essential crystalline phase. (ASTM C242).

Andalusite
A polymorph, along with sellimanite and kyanite, of composition A1203 Si02. On firing, it dissociates to yield principally mullite. (ASTM C 21)

Anglar
Masonry composed of squared stones; one pattern of masonry construction.

Angle curing
Steam curing of concrete products, sand-lime brick, asbestos-cement products, hydrous calcium silicate insulation products, or cement in an autoclave at maximum ambient temperatures generally between 340-420 F (176-215 C).

Angle divider
The angle divider is used by the tile setter to determine the degree of an angle to cut. It is used for fitting trim, moldings, and floors into corners. A corner angle is measured by adjusting the divider to fit the corner.

ANSI
American National Standards Institute

Anti Fracture Membrane
See Crack-isolation.

APA
The Engineered Wood Association

Apron
Trim or facing on the side or in front of a countertop, table edge or windowsill.

ASTM
American Society for Testing and Materials

Autoclave
A pressure vessel in which an environment of steam at high pressure may be produced; used in the curing of concrete products and in the testing of hydraulic cement.

Back wall
The wall facing an observer who is standing at the entrance to a room, shower, or tub shower.

Backing
Any material used as a base over which ceramic tile is to be installed. See Substrate.

Backing off
See Feather edging tile. Angle tile.
Balanced cuts
Cuts of tile at the perimeter of an area that will not take full tiles. The cuts on opposite sides of such an area shall be the same size. The same sized cuts will be placed on each side of a miter.

Ball clay
A secondary clay, commonly characterized by the presence of organic matter, high plasticity, high dry strength, long vitrification range, and a light color when fired. (ASTM C242).

Ball milling
A method of grinding and mixing material, with or without liquid, in a rotating cylinder or conical mill partially filled with grinding media such as balls or pebbles. (ASTM C242).

Bar support
A rigid device used to support or hold reinforcing bars in proper position to prevent displacement before or during concrete placement.

Basalt ware
A black unglazed vitreous ceramic ware having the appearance of basalt rock. (ASTM C242).

Base
One or more rows of tile installed on a vertical surface above the floor. See Cove.

Basis for acceptance
The method of determining whether a lot of ceramic tile is acceptable under these specifications.

Batch mixer
A machine that mixes batches of concrete or mortar in contrast to a continuous mixer.

Batch plant
An operating installation of equipment including batchers and mixers as required for batching or for batching and mixing concrete materials; also called mixing plant when equipment is included.

Beating block
A wooden block used to embed tiles in a flat plane. The method used is called beating in.

Belleek china
A highly translucent whiteware composed of a body containing a significant amount of frit and normally having a luster glaze. (Produced commercially at Belleek, Ireland.) (ASTM C242).

Bench mark
Permanent reference point or mark.

Bentonite
A clay composed principally of minerals of the montmorillonoid group, characterized by high absorption and very large volume change with wetting or drying. Beryllium oxide (berylla) (BeO) An inorganic material of exceptionally high thermal conductivity that is toxic in the powder form.

Bicottura
Method for producing tile by firing it twice (first fire is for body, second is to fuse glazes or patterns in glaze onto the body). Usually, there are two glazes on the tile, first a non-transparent glaze on the body, then a transparent glaze on the surface.

Biscuit chips
Glazed-over chips on the edge or corner of the body of a tile.

Biscuit cracks
Any fractures in the body of a tile visible both on face and back.

Bisque fire
See Fire, bisque.

Blaine fineness
The fineness of powdered materials such as cement and pozzolans, expressed as surface area usually in square centimeters per gram, determined by the Blaine apparatus.

Bleb
A small blister or bubble.

Bleeding
The autogenous flow of mixing water within, or its emergence from newly placed concrete or mortar; caused by the settlement of the solid materials within the mass; also called water gain.

Blend
To mix or make homogeneous.

Blistering
The development during firing of enclosed or broken macroscopic vesicles or bubbles in a body, or in a glaze or other coating.
(ASTM C242).

Block angle
A square of tile specially made for changing direction of the trim such as butterfly or down angle.

Bloom
A visible exudation or efflorescence on the surface.

Blots
Marks or stains on the face of a tile.

Blunging
The wet process of blending, or suspending ceramic material in liquid by agitation. (ASTM C242). The structural portion of a ceramic article. This term also refers to the material or mixture from which the article is made. (ASTM C242).

Body
The structural portion of a ceramic tile. This term also refers to the material or mixture from which the tile is made.

Bond
The adherence of one material to another.

Bond breaker
Any material preventing adhesion.

Bond coat
A material used between the back of the tile and the prepared surface. Suitable bond coats include pure Portland cement, Dry-Set Portland cement mortar, latex-type Portland cement mortar, organic adhesive, and the like.

Bond Strength
A bond coat's ability to resist separating from the tile and setting bed. Measured in pounds per square inch (psi).

Bonding agent
A substance applied to a substrate to create a bond between it and a succeeding layer, such as between a subsurface and a terrazzo topping or a succeeding plaster application.

Bone ash
Calcined bone consisting essentially of calcium phosphate. (ASTM C242).

Bone china
A translucent china made from a ceramic whiteware body composition containing a minimum of 25 percent bone ash. (ASTM C242).

Box Screed
Essentially a box screed is a jig used to apply mortar onto the back side of large-sized ceramic, marble and granite tiles that may vary in thickness, in order to achieve a uniform unit of thickness of the tile and mortar combined.

Brick trowel
The brick trowel is larger than the buttering trowel. The most popular size used by tile setters is 5" wide and 11" long. It is used when any preparatory brick work has to be done. Some tile setters use it for quarry and terra cotta tile work. Its greater surface and weight are advantageous in the buttering and tapping in of the larger tiles.

Brick Veneer Tile
Tile produced by several methods to simulate the appearance of brick.

Bridge
A straightedge used as a starting line for the laying of tile. The straightedge can be blocked up to support tile over an opening.

Bridge deck
The slab or other structure forming the travel surface of a bridge.

Bright glaze
Colorless or colored ceramic glaze having high gloss. (ASTM C242).

Broom finish
The surface texture obtained by stroking a broom over freshly placed concrete. (See also Brushed surface.)

Brown coat
The second coat in three-coat plaster application.

Brushed surface
A sandy texture obtained by brushing the surface of freshly placed or slightly hardened concrete with a stiff brush for architectural effect or, in pavements, to increase skid resistance. (See also Broom finish.)

Building official
The official charged with administration and enforcement of the applicable building code or his duly authorized representative.

Bulking
Increase in the bulk volume of a quantity of sand in a moist or wet condition over the volume of the same quantity of dry sand.

Bulking curve
Graph of change in volume of a quantity of sand due to change in moisture content.

Bulking factor
Ratio of the volume of moist sand to the volume of the sand when dry.

Bull float
A tool comprising a large, flat, rectangular piece of wood, aluminum, or magnesium usually 8 in. (20 cm) wide and 42 to 60 in. (100 to 150 cm) long, and a handle 4 to 16 ft. (1 to 5 cm) in length used to smooth unformed surfaces of freshly placed concrete.

Bullnose
A trim tile with a convex radius on one edge. This tile is used for finishing the top of a wainscot or for turning an outside corner.

Bullnose corner
A type of bullnose trim with a convex radius on two adjacent edges.

Burlap
A coarse fabric of jute, hemp, or less commonly, flax, for use as a water-retaining covering in curing concrete surfaces; also called Hessian.

Bushhammer
A hammer that has a rectangular head with serrated or jagged faces. The bushhammer is used for roughing concrete to provide a bond for masonry.

Butt joint
A plain square joint between two members.

Butterfly
A term commonly used for inside corner angles for trim shapes such as AB 106, AF 105, AF 200, AK 106, and AU 106.

Buttering
The spreading of a bond coat (followed by a mortar coat, a thin-setting bed mortar, or an organic adhesive) to the backs of ceramic tile just before the tile is placed.

Buttonback Tile
Tiles that have projections on the bondable side. Many of these projections are round and therefore the term buttonback. Some projections are quite thick and can also be other shapes, such as square.

Calcine
A ceramic mineral or mixture fired to less than fusion for use as a constituent in a ceramic composition. (ASTM C242).

Camber
A deflection that is intentionally built into a structural element or form to improve appearance or to nullify the deflection of the element under the effects of loads, shrinkage and creep.

Cap
See Bullnose.

Capillary action
Capillary action (sometimes called capillarity, capillary motion, capillary rise, capillary effect, or wicking) is the process of a liquid flowing in a narrow space without the assistance of, or even in opposition to, any external forces like gravity.

Capillary break
Capillary break means a material or system installed to stop the movement of moisture into a building by capillary action.

Cassiterite (Sri 02)
An inorganic mineral of the tetragonal form used as a source of tin and tin oxide. (ASTM C 21)

Cast-in-place
Mortar or concrete that is deposited in the place where it is required to harden as part of the structure, as opposed to precast concrete.

Casting
Forming ceramic ware by introducing a body slip into a porous mold that absorbs sufficient water from the slip to produce a semi rigid article. (ASTM C242).

Casting plaster
A fast-setting gypsum plaster that is used to anchor marble to walls, set spots, or mix temporary "hot mud."

Casting solid
Forming ceramic ware by introducing a body slip into a porous mold that usually consists of two major sections, one section forming the contour of the inside of the ware and allowing a solid cast to form between the two mold faces. (ASTM C242).

Casting, drain (hollow casting)
Forming ceramic ware by introducing a body slip into an open porous mold, and then draining off the remaining slip when the cast has reached the desired thickness. (ASTM C242).

Caulk
See Sealant.

Caulking compound
A soft, plastic material consisting of pigment and vehicle, used for sealing joints in buildings and other structures where normal structural movement may occur. Caulking compound retains its plasticity for an extended period after application. It is available in forms suitable for application by gun and knife and in extruded preformed shapes.

Ceiling mortar
Extra-rich wall mortar.

Cement
Usually refers to Portland cement that when mixed with sand, gravel, and water forms concrete. Generally, cement is an adhesive; specifically, it is that type of adhesive that sets by virtue of a chemical reaction.

Cement grout
A cementitious mixture of Portland cement, sand or other ingredients and water that produces a water resistant, uniformly colored material used to fill joints between tile units.

Cement mortar
A cementitious mixture of Portland cement, sand or other ingredients and water that is used for bonding tile to back-up material.

Cement, Portland
A hydraulic cement produced by pulverizing clinker consisting essentially of hydraulic calcium silicates, and usually containing one or more of the forms of calcium sulfate as an interground addition.

Cement, white
Portland cement that hydrates to a white paste; made from raw materials of low iron content, the clinker for which is fired by a reducing flame.

Cement, masonry
A hydraulic cement for use in mortars for masonry construction, containing one or more of the following materials: Portland cement, Portland blast-furnace slag cement, Portland-pozzolan cement, natural cement, slag cement or hydraulic lime; and in addition usually containing one or more materials such as hydrated lime, limestone, chalk, calcareous shell, talc, slag, or clay, as prepared for this purpose.

Cement-body tiles
Tiles with the body made from a mixture of sand and Portland cement. The surface may be finished with Portland cement, spheroids of marble or other materials.

Cementitious
Having the properties of cement.

Centigrade
A scale of temperature that features 0°C and 100°C as the freezing and boiling point of water respectively. To convert Centigrade to Fahrenheit multiply by 1.8 and add 32, e.g., (100°Cx1.8)- 32=212°F. Also known as Celsius.

Ceramic article
An article having a glazed or unglazed body of crystalline or partly crystalline

structure, or of glass, the body of which is produced from essentially inorganic, nonmetallic substances and either is formed from a molten mass that solidifies on cooling or is formed and simultaneously or subsequently matured by the action of the heat. (ASTM C242).

Ceramic mosaic tile
An unglazed tile formed by either the dust-pressed or plastic method, usually 1/4 to 3/8 in. (6.4 to 9.5 mm) thick, and having a facial area of less than 6 in. and that is usually mounted on sheets approximately 2 by 1 ft. (0.3 by 0.6 m) to facilitate setting. Ceramic mosaic tile may be of either porcelain or natural clay composition and may be either plain or with an abrasive mixture throughout. (ASTM C242).

Ceramic paste
A French term synonymous with “ceramic body.” (ASTM C242).

Ceramic process
The production of articles or coatings from essentially inorganic, nonmetallic materials, the article or coating being made permanent and suitable for utilitarian and decorative purposes by the action of heat at temperatures sufficient to cause sintering, solid-state reactions, bonding, or conversion partially or wholly to the glassy state. (ASTM C242).

Ceramic tile
A ceramic surfacing unit, usually relatively thin in relation to facial area, made from clay or a mixture of clay; and other ceramic material, called the body of the tile, having either a “glazed” or “unglazed” face, and fired above red heat in the course of manufacture to a temperature sufficiently high to produce specific physical properties and characteristics.

Ceramic whiteware
A fired ware consisting of a glazed or unglazed ceramic body that is commonly white and of fine texture. This term designates such products as china, porcelain, semi vitreous ware and earthenware. (ASTM C242).

Ceramics
A general term applied to the art or technique of producing articles by a ceramic process, or to the articles so producing. (ASTM C242).

Chair
See Bar support.

Chalk line
Usually cotton cord coated with chalk. The cord is snapped to mark a straight line. The chalk line is used to align spots or screeds.

Checking
Short shallow cracks on the surface. Chemical porcelain. Vitreous ceramic whitewares used for containing, transporting, or reacting of chemicals. (ASTM C242).

China
A glazed or unglazed vitreous ceramic whiteware used for nontechnical purposes. This term designates such products as dinnerware, sanitary ware, and art ware when they are vitreous. (See also Bone china.) (ASTM C242).

China process
The method of producing glazed ware by which the ceramic body is fired to maturity, following which the glaze is applied and matured by firing at a lower temperature. (ASTM C242).

China sanitary ware (sanitary plumbing fixtures)
Glazed, vitrified whiteware fixtures having a sanitary service function. (ASTM C242).

Chipped
Caused from the same reasons as given under “pitted” or by rough handling and confined to the corners and edges of the tile.

Chipping hammer
The chipping hammer is a lightweight hammer that comes in a variety of sizes. The head and back can be capped with tungsten carbide for durability. It is used by the tile setter to chip excess material from the backs and edges of wall and quarry tiles, thus reducing the amount of grinding work necessary to smooth a cut.

Chips
The scaling or breaking off at the edges of fragments from the surface of a tile, as might result from rough handling.

Clay
A natural mineral aggregate, consisting essentially of hydrous aluminum silicates; it is plastic when sufficiently wetted, rigid when dried en masse, and vitrified when fired to a sufficiently high temperature. (ASTM C242).

Clear glaze
A colorless or colored transparent ceramic glaze. (ASTM C242).

Cleavage membrane
A layer of 15 lb. roofing felt, or an equivalent type of construction paper or polyethylene sheeting, used to isolate a wire reinforced mortar bed for tile from the concrete substrate. (CTI)

Clinker
A brick with a vitrified surface.

Cold joint
Any point in a tile installation where tile and setting bed have terminated and the surface has lost its plasticity before work is continued.

Cold joint lines
Visible lines on the surfaces of formed concrete indicating the presence of joints where one layer of concrete had hardened before subsequent concrete was placed. (See also Cold joint).

Color
The aspect of the appearance of an object dependent upon the spectral composition of the incident light, the spectral reflectance of transmittance of the object, and the spectral response of the observer.

Colored grout
Commercially prepared grout consisting of carefully graded aggregate, Portland cement, water dispersing agents, plasticizers and color fast pigments. (CTI).

Column
A member used primarily to support axial compression loads and with a height of at least three times its least lateral dimension.

Compaction
The process whereby the volume of freshly placed mortar or concrete is reduced to the minimum practical space usually by vibration, centrifugation, tamping, or some combination of these; to mold it within forms or molds and around embedded parts and reinforcement, and to eliminate voids other than entrained air.

Composition tile
A hard tile surfacing unit made from a mixture of chemicals. The finished surface can be the mixture of chemicals or can be marble chips to create a terrazzo finish. The unit is made hard by the set of the chemicals and the product is not fired as in the manufacture of ceramic tile. (CTI)

Compressive strength
The measured maximum resistance of a concrete or mortar specimen to axial loading; expressed as force per unit cross-sectional area; or the specified resistance used in design calculations, in the U.S. customary units of measure expressed in pounds per square inch (psi).

Concrete
A composite material that consists essentially of a binding medium within which are embedded particles or fragments of aggregate; in Portland cement concrete, the binder is a mixture of Portland cement and water.

Concrete pump
An apparatus that forces concrete to the placing position through a pipeline or hose. Concrete, prestressed. See Prestressed concrete. Concrete, pumped. See Pumped concrete.

Concrete, fibrous
Concrete containing dispersed, randomly oriented fibers.

Concrete, field
Concrete delivered or mixed, placed, and cured on the job site.

Concrete, foamed
Concrete made very light and cellular by the addition of a prepared foam or by generation of gas within the unhardened mixture.

Concrete, green
Concrete that has set but not appreciably hardened.

Concrete, lightweight
Concrete using lightweight aggregates or combination of lightweight and normal- weight aggregates. Structural lightweight concrete air-dry density ranges from 85 to 115 PCF and compressive strength is in excess of 2500 PSI.

Concrete, precast
See Precast concrete.

Concrete, refractory
See Refractory concrete.

Concrete, terrazzo
Marble-aggregate concrete that is cast-in-place precast and ground smooth for decorative surfacing purposes on floors and walls.

Condensation
Usually refers to liquid drops that form when a vapor is chilled below its boiling point. Also refers to water droplets that deposit on surfaces whose temperature is below the dew point. Conductive (adj.) Having the quality or power of conducting or transmitting heat, electricity, or static electricity.

Conductive mortar
A tile mortar to which specific electrical conductivity is imparted through the use of conductive additives.

Conductive tile
Tile made from special body compositions or by methods that result in specific properties of electrical conductivity while retaining other normal physical properties of ceramic tile.

Contaminated
Stained tile as a result of carton and tile being saturated by moisture, oils, solvents or other materials.

Contraction joint
Formed, sawed, or tooled groove in a concrete structure to create a weakened plane and regulate the location or cracking resulting from the dimensional change of different parts of the structure. (See also Isolation joint.)

Control joints
See Contraction joint. (*TCNA Handbook*)

Conventional installation
The method of installing ceramic tile with Portland cement mortar.

Coping
The material or units used to form a cap or finish on top of a wall, pier, pilaster, or chimney.

Corbel
A projection from the face of a beam, girder, column, or wall used as a beam seat or a decoration.

Cordierite porcelain
A vitreous ceramic whiteware for technical application in which cordierite is the essential crystalline phase. (ASTM C242).

Cordierite whiteware
A ceramic whiteware in which cordierite is the essential crystalline phase. (ASTM C242).

Corrosion
The eating and wearing away by chemical action (pitting, rusting).

Cove
A trim tile unit having one edge with a concave radius. A cove is used to form a junction between the bottom wall course and the floor or to form an inside corner.

Cove base (sanitary)
A trim tile having a concave radius on one edge and a convex radius with a flat landing on the opposite edge. This base often is used as the only course of tile above the floor tile.

Coverage
A measure of the amount of material required to cover a given surface.

Covering power
The ability of a glaze to uniformly and completely cover the surface of the fired water. (ASTM C242).

Crack-control reinforcement
Reinforcement in concrete construction designed to prevent opening of cracks, often effective in limiting them to uniformly distributed small cracks.

Cracked
Tiles that have actually been cracked in one or more pieces usually during the beating in process of installation. These will show up as hairline cracks.

Crack-Isolation
Prevention of transfer of cracks from the substrate through the tile or stone when substrate is subjected to horizontal movement of cracks.

Cracks
Hair-line fissures.

Crawling
A parting and contraction of the glaze on the surface of ceramic ware during drying or firing, resulting in unglazed areas bordered by coalesced glaze. (ASTM C242-58T)

Crazing
The cracking that occurs in fired glazes or other ceramic coatings due to critical tensile stresses. (ASTM C242).

Creep
Time-dependent deformation due to sustained load.

Crooked edges
A curvature of the sides, either convex or concave, measured along the sides. The degree of crook is the departure from the straight line between two corners, expressed in percentage of the tile length.

Crow hop
A slang term used to describe tile joints that are out of alignment.

Crystalline glaze
Glazed tile with an extra heavy glaze produced for use on counter tops and light duty floor surfaces where abrasion or impact is not excessive. (CTI)

CSI
Construction Specification Institute
CTDA
Ceramic Tile Distributors Association

CTEF
Ceramic Tile Education Foundation

CTI
Certified Tile Installer

CTIOA
Ceramic Tile Institute of America

Curing
Maintenance of humidity and temperature of freshly placed concrete during some definite period following placing, casting, or finishing to assure satisfactory hydration of the cementitious materials and proper hardening of the concrete.

Curing blanket
A built-up covering of sacks, matting, hessian, straw, waterproof paper, or other suitable material placed over freshly finished concrete. (See also Burlap.)

Curing compound
A liquid that can be applied as a coating to the surface of newly placed concrete to retard the loss of water or, in the case of pigmented compounds, also to reflect heat so as to provide an opportunity for the concrete to develop its properties in a favorable temperature and moisture environment. (See also Curing.)

Curing, electrical
A system in which a favorable temperature is maintained in freshly placed concrete by supplying heat generated by electrical resistance. Curing, steam. See Steam curing.

Curling
The distortion of an originally essentially linear or planar member into a curved shape such as the warping of a slab due to creep or to differences in temperature or moisture content in the zones adjacent to its opposite faces.

Cushion-edged tile
Tile on which the facial edges have a distinct curvature that result in a slightly recessed joint.

D-cracking
The progressive formation on a concrete surface of a series of fine cracks at rather close intervals, often of random patterns. Evidenced in slabs on grade by cracks paralleling edges or joints and curving across slab corners. (Also termed D-cracks and D-line cracks.)

D-load
A constant load that in structures is due to the mass of the members, the supported structure, and permanent attachments or accessories.

Dago float
A slang term used to describe the use of a fresh mortar screed in lieu of float strips to rod floor mortar. This method is commonly used in floor work. Terrazzo workers use this technique to align “concrete” for placement of brass or aluminum strips to the desired grade.

Dago stick
A slang term used by tile setters when referring to a small piece of wood used to rod off mortar that has been applied to fill the holes caused by the removal of float strips.

Darby
A hand-manipulated straightedge, usually 3 to 5 ft. (1 to 2.5m) long, used in the early stage leveling operations of concrete or plaster, preceding supplemental floating and finishing.

Dash-bond coat
A thick slurry of Portland cement, sand and water flicked on surfaces with a paddle or brush to provide a base for subsequent Portland cement plaster coats; sometimes used as a final finish on plaster.

Deck
The form on which concrete for a slab is placed, also the floor or roof slab itself. (See also Bridge deck.)

Deck or floor mortar
Mortar commonly used for decks or floors. It consists of sand and regular Portland cement mixed with water to a firm consistency.

Decorated
Adorned, embellished, or made more attractive by means of color or surface detail. (ASTM C242).

Decorating fire
See Fire, decorating.

Decoration
See Decoration, inglaze; Decoration, overglaze; Decoration, underglaze.

Decoration, inglaze
A ceramic decoration applied on the surface of an unfired glaze and matured with the glaze. (ASTM C242).

Decoration, overglaze
A ceramic or metallic decoration applied and fired on the previously glazed surface of ceramic ware. (ASTM C242).

Decoration, underglaze
A ceramic decoration applied directly on the surface of ceramic ware and subsequently covered with a transparent glaze. (ASTM C242).

Decorative tile
Tile with a ceramic decoration on the surface. (See heading under Decorated and Decoration.)

Deflection
A variation in position or shape of a structure or structural element due to effects of load or volume change, usually measured as a linear deviation from an established plane rather than an angular variation.

Deformation eutectic
See Eutectic, deformation.

Delft ware
A calcareous earthenware having an opaque white glaze and monochrome overglaze decorations. (Originated in Delft, Holland.) (ASTM C242).

Discoloration
Departure of color from that which is normal or desired.

Divider strips
In terrazzo work, nonferrous metal or plastic strips of different thickness, and embedded depths usually 5/8 to 1/4 in. (10 to 40 mm), used to form panels in the topping.

Dolomite
The double carbonate of lime and magnesia having the general formula CaCO3 MgCA3. (ASTM C242).

Dope coat
Neat cement applied to the setting bed.

Double Bullnose
A type of trim with the same convex radius on two opposite sides.

Dowel
A steel pin, commonly a plain round steel bar, that extends into two adjoining portions of a concrete construction, as at a joint in a pavement slab, so as to connect the portions and transfer shear loads. Also, as used in the construction of column and wall sections, a deformed steel reinforcing bar placed so as to transmit tension or compression as well as shear loads.

Down Angle
Trim tile with two rounded or curved edges, that serves to finish an outside corner.

Drain casting
See Casting, drain.

Dry edging
Rough edges and corners of glazed ceramic ware due to insufficient glaze coating. (ASTM C242). Dry mix. See Process, dry.

Dry pack
Concrete or mortar mixtures deposited and consolidated by dry packing.

Dry packing
Placing of zero slump, or near zero slump, concrete, mortar, or grout by ramming into a confined space.

Dry pressing
See Pressing, dry.

Dry process
See Process, dry.

Dry spots
Small areas on the face of tile that have been insufficiently glazed.

Dry-set mortar
A water-retentive hydraulic cement mortar usable with or without sand. When this mortar is used, neither the tile nor walls have to be soaked during the installation process.

Drying
Removal by evaporation, of uncombined water or other volatile substance from a ceramic raw material or product, usually expedited by low temperature heating. (ASTM C242).

Dunting
The cracking that occurs in fired ceramic bodies due to thermally induced stresses. (ASTM C242-72)

Dusting
The application of dry Portland cement to a wet floor or deck mortar surface. A pure coat is thus formed by suction of the dry cement.

Dutchman
A cut tile used as a filler in the run of a wall or floor area.

Eagle beak
A 6”x3/4” outside corner trim shape. (AC 106) Earthenware. A glazed or unglazed nonvitreous ceramic whiteware. (ASTM C242).

Edge-mounted tile
A type of mounted tile. Tile is assembled into units or sheets and is bonded at the edges or corners of the back of the tiles by an elastomeric or resinous material that becomes an integral part of the tile installation. Units or sheets must meet criteria of back-mounted sheets. See definition for Mounted tile.

Edge-bonded tile
See definition for Pregrouted tile.

Edger
A finishing tool used on the edges of fresh concrete to provide a rounded corner.

Efflorescence
The residue deposited on the surface of a material by the crystallization of soluble salts.

Egg shelling
The texture of a fired glaze similar in appearance to the surface of an eggshell. (ASTM C242).

Electrical porcelain
Vitrified white ware having an electrical insulating function. (ASTM C242).

Electrolysis
Production of chemical changes by the passage of current through an electrolyte.

Elastomeric
A natural material, for example, rubber, or a synthetic material. for example, polyvinyl, that has elastic properties.

Embossed
A decoration in relief or excised on the ware surface. (ASTM C242).

Engobe
A slip coating applied to a ceramic body for imparting color, opacity or other characteristics, and subsequently covered with a glaze. (ASTM C242).

Entrained air
Microscopic air bubbles intentionally incorporated into mortar or concrete during mixing, usually by use of a surface-active agent. (See also Air entrainment.)

Epoxy adhesive
A two-part adhesive system employing epoxy resin and epoxy hardener used for bonding of ceramic tile to back-up materials.

Epoxy grout
A two-part grout system consisting of epoxy resin and epoxy hardener, especially formulated to have impervious qualities, stain, and chemical resistance used to fill joints between tile units.

Epoxy mortar
A two-part mortar system consisting of epoxy resin and epoxy hardener used to bond tile to back-up material where chemical resistance of high bond strength is a consideration.

Epoxy resin
An epoxy composition used as a chemical resistant setting adhesive or chemical-resistant grout.

Equilibrium eutectic
See Eutectic, equilibrium. Eutectic. See Eutectic, deformation; Eutectic, equilibrium.

Eutectic, deformation
The composition within a system of two or more components that, on

heating under specific conditions, develops sufficient liquid to cause deformation at minimum temperature. (ASTM C242). Eutectic equilibrium (eutectic). The composition within any system of two or more crystalline phases that melts completely at minimum temperature, or temperature at which such a composition melts. (ASTM C242).

Expansion joint
A joint through tile, mortar, and reinforcing wire down to the substrate.

Exposed-aggregate finish
A decorative finish for concrete work achieved by removing, generally before the concrete has fully hardened, the outer skin of mortar and exposing the coarse aggregate.

Extra duty tile
See Special purpose tile.

Extruded tile
A tile or trim unit that is formed when plastic clay mixtures are forced through a pug mill opening (die) of suitable configuration, resulting in a continuous ribbon of formed clay. A wire cutter or similar cut-off device is then used to cut the ribbon into appropriate lengths and widths of tile.

Face Mounted Tile
See mounted tile.

Facial defect
That portion of the facial surface of the tile that is readily observed to be nonconforming and that will detract from the aesthetic appearance or serviceability of the installed tile.

Faience mosaics
Faience that are less than 6˝ in facial area, usually 5/16˝ to 3/8˝. (8 to 9.5 mm) thick, and usually mounted to facilitate installation. (ASTM C242).

Faience tile
Glazed or unglazed tile, generally made by the plastic process, showing characteristic variations in the face, edges, and glaze that give a handcrafted, nonmechanical, decorative effect. (ASTM C242).

Faience ware
Formerly decorated earthenware with an opaque glaze, but currently designating a decorated earthenware having a transparent glaze (ASTM C242).

Fan or fanning
Spacing tile joints to widen certain areas so they will conform to a section that is not parallel.

Fascia
A flat member or band at the surface of a building or the edge beam of a bridge; exposed eave of a building; often inappropriately called fascia.

Feather edge
A wood or metal tool having a beveled edge; used to straighten re-entrant angles in finish plaster coat; also edge of a concrete or mortar placement such as a patch or topping that is beveled at an acute angle.

Featheredging file (mitering)
The method of chipping away the body from beneath a facial edge of a tile in order to form a miter.

Feature strip (decorative liner)
A narrow strip of tile that has a contrasting color, texture, or design.

Feldspar
A mineral aggregate consisting chiefly of microcline, albite and/or anorthite. (ASTM C242)

Fiberglass
The name for products made of or with glass fibers ranging from 5 to 600 hundred-thousandths inch in diameter. Used for making textile fabrics and for heat or sound insulation.

Field tile
Tile other than trim tile covering a wall or floor.

Filler
See Spacing mix.

Final setting time
The time required for a freshly mixed cement paste, mortar or concrete to achieve final set.

Fire
See Fire, bisque; Fire, decorating; Fire, glost; Fire, single.

Fire clay
An earthy or stony mineral aggregate that has as the essential constituent hydrous silicates of aluminum with or without free silica, plastic when sufficiently pulverized and wetted, rigid when subsequently dried, and of suitable refractoriness for use in commercial refractory products.

Fineness modulus
A factor obtained by adding the total percentages by weight of an aggregate sample retained on each of a specified series of sieves, and dividing the sum by 100. In the United States the standard sieve sizes are No. 100 (150 pm), No. 30 (600 wm), No. 16 (1.18 mm), No. 8 (2.36 mm) and No. 4 (4.75 mm), and a/s in. (9.5 mm), 3/a in. (19 mm), 11/2 in. (38,1 mm), 3 in. (75 mm), and 6 in. (150 mm).

Fire, bisque
The process of kiln-firing ceramic ware prior to glazing. (ASTM C242).

Fire, decorating
The process of firing ceramic or metallic decorations on the surface of glazed ceramic ware. (ASTM C242).

Fire, glost
The process of kiln-firing bisque ware to which glaze has been applied. (ASTM C242).

Fire, single
The process of maturing an unfired ceramic body and its glaze in one firing operation. (ASTM C242).

Firing
The controlled heat treatment of ceramic ware in a kiln or furnace, during the process of manufacture, to develop the desired properties. (ASTM C. 242).

Firing range
The range of firing temperature within which a ceramic composition develops properties that render it commercially useful. (ASTM C242).

Flat Back-Troweling (formerly backbutter)
The spreading of a bond coat to the backs of ceramic tile just before the tile is placed.

Flaked
Irregularities left on the edge of the tile mainly due to the use of machine cutting tools.

Flammable
Capable of being easily ignited.

Flash point
The temperature at which the material gives off flammable vapor in sufficient

quantity to ignite momentarily on the application of a flame under specified conditions.

Flash set
Flash set is the rapid development of rigidity with the evolution of considerable heat. Plasticity cannot be regained. Rapid development of rigidity would interfere with delivery and placement operations. Flash set would make concrete unusable, and concrete hardened in the mixer could not be removed easily.

Flexural strength
A property of a material or structural member that indicates its ability to resist failure in bending. (See also Modulus of rupture.)

Float coat
The final mortar coat over which the neat coat, pure coat, or skim coat is applied.

Float strip
A strip of wood about 1/4” thick and 1-1/2” wide. It is used as a guide to align mortar surfaces.

Floating
A method of using a straightedge to align mortar with the float strips or screeds. This technique also is called dragging, pulling, rodding, or rodding off.

Fluorite (Ca F2) (fluorspar)
An inorganic mineral of the isometric form, used as a source of fluorine for fluxing of glasses and glazes.

Flux
A substance that promotes fusion in a given ceramic mixture. (ASTM C242).

Fog curing
1. Storage of concrete in a moist room in which the desired high humidity is achieved by the atomization of fresh water. (See also Moist room).
2 Application of atomized fresh water to concrete, stucco, mortar, or plaster.

Form oil
Oil applied to interior surface of formwork to promote easy release from the concrete when forms are removed.

Forming
The shaping or molding of ceramic ware. (ASTM C242).

Forsterite porcelain
A vitreous ceramic whiteware for technical application in which forsterite (2MgO SiO) is the essential crystalline phase. (ASTM C242).

Forsterite whiteware
Any ceramic whiteware in which forsterite (2MgO - SiO) is the essential crystalline phase. (ASTM C242).

Freehand floating
The application of wall mortar without the use of guide screeds. This technique is used by specialists when they are setting glass mosaic murals.

Free Lime
Calcium oxide that survives processing without reacting in building products such as cement.

Frit
A glass that contains fluxing material and is employed as a constituent in a glaze, body or other ceramic composition. (ASTM C242).

Fritted glaze
A glaze in which a part or all of the fluxing constituents are prefused. (ASTM C242).

Frost proof tile
Tile produced for use where freezing and thawing conditions occur. (CTI)

Furan mortar
A two-part mortar system of furan resin and furan hardener used for bonding tile to back-up material where chemical resistance of floors is important.

Furan Plastics
Plastics based on resins in which the furan ring is an integral part of the polymer chain, made by the polymerization or polycondensation of furfural, furfuryl alcohol, or other compounds containing a furan ring, or by the reaction of these furan compounds with other compounds, the furan being in greater amount by weight.

Furan Grout
An intimate mixture of a furan resin, selected fillers and an acid catalyst. Fillers are generally carbon, silica or a combination thereof into which the acid catalyst, or setting agent, may be incorporated. When combined, the components form a flowable chemical resistant material for grouting tile.

Furan resin
A furan resin composition used as a chemical-resistant setting adhesive or chemical-resistant grout.

Furan resin grout
A two-part grout system of furan resin and furan hardener used for filling joints between quarry tile and pavers where chemical resistant properties are required.

Furring
Stripping used to build out a surface such as a studded wall where strips of suitable size are added to the studs to accommodate vent pipes or other fixtures.

Fusion
The process of melting; usually the result of interaction of two or more materials. (ASTM C242).

Gilmore needle
A device used in determining time of setting of hydraulic cement.

Glass Mesh Mortar Unit/Cementitious Backer Unit
A backer board designed for use with ceramic tile in wet areas. It can be used in place of metal lath, Portland cement scratch coat and mortar bed.

Glass mosaic tiles
Tiles made of glass, usually in sizes not over two (2) inches square and 1/4 inch thick, mounted on sheets of paper. Usually sheets are twelve (12) inches square.

Glaze
A ceramic coating matured to the glassy state on a formed ceramic article. The term glaze also refers to the material or mixture from which the coating is made. (ASTM C242). Bright glaze. A high-gloss coating with or without color. (ASTM C242). Clear glaze. A transparent glaze with or without color. (ASTM C242). Crystalline glaze. A glaze that contains microscopic crystals. (ASTM C242). Fritted glaze. A glaze in which a part or all of the fluxing constituents are prefused. (ASTM C242). Matt glaze. A low-gloss ceramic glaze with or without color. (ASTM C242). Opaque glaze. A nontransparent glaze with or without color. (ASTM C242). Raw glaze. A glaze compounded primarily from raw constituents. It contains no prefused materials. (ASTM C242). Semi matte glaze. A medium-gloss ceramic glaze with or without color. (ASTM C242). Speckled glaze. A glaze containing granules of oxides or ceramic stains that are of contrasting colors.

Glaze fit
The stress relationship between the glaze and body of a fired ceramic product. (ASTM C242).

Glazed interior tile
A glazed tile with a body that is suitable for interior use and that is usually nonvitreous, and is not required or expected to withstand excessive impact or be subject to freezing and thawing conditions. (ASTM C -242).

Glazed paver tile
See Pavers. Glazed quarry tile. See Quarry tile. Glazed tile. Tile with a fused impervious facial finish composed of ceramic materials, fused into the body of the tile which may be a nonvitreous, semi vitreous, vitreous, or impervious body. The glazed surface may be clear, white, or colored. (ASTM C242). Glazed tile, extra duty glaze. Tile with a durable glaze that is suitable for light duty floors and all other surfaces on interiors where there is no excessive abrasion or impact. (ASTM C242).

Glost fire
See Fire, glost.

Grade
A predetermined degree of slope for floors requiring drainage.

Grades
Grades of tile recognized in ANSI standard specifications for ceramic tile.

Grout
A rich or strong cementitious or chemically setting mix used for filling tile joints.

Grouting
The process of filling the tile joints with grout.

Grout saw
The grout saw is a saw-toothed carbide steel blade mounted on a wooden handle. It is used to remove old grout. It also is used in patching work. Care should be used as it can easily damage adjacent tiles. The carbide steel blade is brittle, and it will shatter if it is dropped or abused. On front of the saw blade is a spring steel tip, used for scraping grout out of corners where the saw blade cannot reach.

Grout scrubbing pad
A no scratch nylon pad impregnated with abrasive used for cleaning grout off tile.

Grout, colored
See Colored grout.

Half and half
See Spacing mix.

Hard screed
A mortar screed that has become firm.

Hard Tile
A term used in the tile trade to designate types of tile, such as ceramic, glass mosaic, marble tile, etc. over which the tile trade has jurisdiction. Hard tile as compared to resilient tile.

Hawk
Hawks range in size from 10" to 14" square, but tile setters generally prefer the 11" square. Most hawks are made of aluminum with a wooden handle at the center. A rubber pad fits over the handle and covers that portion of the metal hawk that would come in contact with the hand. The hawk should not be held with a hand that is wet or covered with lime or mortar.

Healing power
The ability of a glaze to heal surface blemishes during firing. (ASTM C242).

Heavy duty tile
Tile suitable for areas where heavy pedestrian traffic is prevalent. Tile can be specified to meet higher test values as determined by job requirements but a minimum heavy duty tile test requirement is necessary.

Hod
A portable trough for carrying mortar, bricks, etc., fixed crosswise on top of a pole and carried on the shoulder.

Hollow casting
See Casting, drain.

Hopped-up mud (aka Hot Mud)
Mortar mixed with an accelerator.

Horizontal broken joints
A style of laying tile with each course offset one-half its length.

Hot cement
Newly manufactured cement that has not had an opportunity to cool after burning and grinding of the component materials.

Hot-Mopped Pan
A type of shower pan made of alternating layers of hot asphalt and tar paper.

Hot mud or hot stuff
Mortar mixed with an accelerator. Hot pressing.- See Pressing, hot, hopped-up mud.

Hue
The attribute by which a perceived color is distinguished as red, yellow, green, blue, purple or a combination of these. White, gray and black colors possess no hue. Lightness – The attribute by which a perceived color is judged to be equivalent to a member of the continuous series of grays ranging from black to white. Saturation – The attribute by which a perceived color is judged to depart from gray of equal lightness toward a pure hue.

Hydrate
A chemical combination of water with another compound or an element.

Hydrated lime
Calcium hydroxide, a dry powder obtained by treating quicklime with Hydraulic – (cement) (mortar) Those products that will set or harden under water.

Impervious
That degree of vitrification evidenced visually by complete resistance to dye penetration. (ASTM C242). NOTE: The term impervious generally signifies zero absorption, except for floor and wall tile that are considered impervious up to 0.5 percent water absorption.

Impervious tile
Water absorption of 0.5 percent or less.

In/Out Corner
Trim tile for turning a right-angle inside or outside wall corner.

Incised
Decorated by cutting or indenting the ware surface. (ASTM C242).

Inglaze decoration
See Decoration, inglaze.

Initial setting time
The time required for a freshly mixed cement paste, mortar, or concrete to

achieve initial set. (See also Final setting time.)

Ironstone ware
(Also called Stone China or Granite Ware) Historic term for a durable English earthenware. (ASTM C242).

ISO
International Standards Organization

Isolation joint
A separation between adjoining parts of a concrete structure, usually a vertical plane, at a designed location such as to interfere least with performance of the structure, yet such as to allow relative movement and avoid formation of cracks elsewhere in the concrete. (See also Contraction joint.)

Jagged edges
Irregularities left on the edges of the tile due to the use mainly of hand cutting tools.

Jasper ware
A vitreous, opaque, colored unglazed ceramic ware having white or contrasting relief-decorations and containing a substantial amount of barite. Originally developed by Josiah Wedgwood. (ASTM C242).

Jiggering
Forming ceramic ware from a plastic body by differential rotation of a profile tool and mold, the mold having the contour of one surface of the ware and the profile tool that of the other surface. (ASTM C242).

Jitterbug
A grate tamper for pushing coarse aggregate slightly below the surface of a slab to facilitate finishing.

Joint filler
Compressible material used to fill a joint to prevent the infiltration of debris and to provide support for sealants.

Joint sealant
Compressible material used to exclude water and solid foreign materials from joints.

Joint, control
See Expansion joint.

Joint, contraction
See Contraction joint.

Joint, expansion
See Expansion joint.

Jointer (concrete)
A metal tool about 6 in. (150 mm) long and from 2 to 4 1/2 in. (50 to 100 mm) wide and having shallow, medium, or deep bits (cutting edges) ranging from 3/16 in. to 3/8 in. (5 to 20 mm) or deeper used to cut a joint partly through fresh concrete.

Journeyman
An experienced reliable worker who has learned his trade and works for another person.

Kaolin (china clay)
A refractory clay consisting essentially of minerals of the kaolin group and that fires to a white or nearly white color. (ASTM C242).

Keene's cement
A cement composed of finely ground, anhydrous, calcined gypsum, the set of which is accelerated by the addition of other materials.

Knockings
The oversize residue obtained in screening a ceramic slip. (ASTM C242).

Kyanite
The most abundant of the mineral polymorphs that include andalusite and sillimanite. Kyanite is used as a source of mullite in ceramics. (ASTM C 21)

L cut
A piece of tile cut or shaped to the letter L.

Laitance
A layer of weak and nondurable material containing cement and fines from aggregates, brought by bleeding water to the top of wet concrete; the amount of which is generally increased by overworking or over manipulating concrete at the surface by improper finishing or by job traffic.

Lap
The length by which one bar or sheet of fabric reinforcement overlaps another.

Latex
A water emulsion of a synthetic rubber or plastic obtained by polymerization and used especially in coatings and adhesives.

Latex-Portland cement grout
A Portland cement grout with a special latex additive that results in a less rigid, less permeable grout than regular Portland cement grout.

Latex-Portland cement mortar
A mixture of Portland cement, sand, and special latex additives that is used for bonding tile to back-up material. It is less rigid than Portland cement mortar.

Lath
A wood strip or metal mesh, which acts as a background or reinforcing agent for the scratch coat or mortar coat.

Layout Lines
Lines chalked on a substrate to guide in accurately setting tile.

Layout stick
A long strip of wood marked at the appropriate joint intervals for the tile to be used. It is used to check the length, width, or height of the tile work. A common name for this item is idiot stick.

Leadless glaze
A ceramic coating matured to a glassy state on a formed article, or the material or the mixture from which the coating is made, to which no lead has been deliberately added. (ASTM C 21) NOTE: This does not imply that the glaze is nontoxic or that it contains no lead. Because of plant practices and conditions, a small percentage of lead, 0.1 to 0.2% (by dry weight), expressed as lead monoxide, may be present.

Leg
A tile wall running alongside a bathtub or abutment. This term sometimes is used to describe a narrow strip of tile wall.

Level
a. A surface or line with all points at the same elevation
b. Horizontally straight.

Leveling coat
See Plumb scratch.

Light duty tile
Tile suitable for limited pedestrian traffic such as entryways in single family residences.

Lime
Specifically, calcium oxide (CaO); also, loosely, a general term for the various chemical and physical forms of quicklime, hydrated lime and hydraulic hydrated lime.

Limestone
A sedimentary carbonate rock, composed chiefly of calcite (Ca CO), but sometimes containing appreciable dolomite. (ASTM C 21)

Lippage
A condition where one edge of a tile is higher than an adjacent tile giving the finished surface an uneven appearance.

Live load
Any load that is not permanently applied to a structure.

Load-bearing wall
A wall designed and built to carry superimposed vertical and shear loads as opposed to no-load-bearing walls.

Lugs
See Self-spacing tile.

Marble mosaic tile
Tile made of small marble tesserae that varies slightly in size, usually about one half inch square and mounted on sheets of paper to facilitate installation. (CTI)

Marble tiles
Quarried marble, usually 3/4" thick or less, various sizes, finishes available are polished, honed, split faced, acid washed etc.

Master Grade certificate
A certificate that states tile listed in the shipment and described on the certificate are made in accordance with TCNA 137.1-76.

Mastic
Tile adhesive.

Mastic grout
A chemical mixture of organic and inorganic ingredients forming a one part grouting composition that is used directly from the manufacturer's container.

Mat glaze
A colorless or colored ceramic glaze having low gloss. (ASTM C242).

Maturing range
The time-temperature range within which a ceramic body, glaze, or other composition may be fired to yield specified properties. (ASTM C242-72)

Medium duty tile
Tile suitable for pedestrian traffic such as entryways in multiple dwellings and lobbies.

Melt
To change a solid into a liquid by the application of heat; or the liquid resulting from such action. (ASTM C242).

Metal quarry tile rack
Metal quarry tile racks are available in many patterns, and they can be made to order for special patterns. They are used to maintain the same width between the quarry tiles.

Mexican paver tile
Terra cotta-like tile, used mainly for floors, and handmade. This tile varies in color, texture and appearance, from tile to tile and within each tile. Available in squares up to 12 inches, hexagon, octagon, elongated hexagon, fleur de lis and other shapes. Tiles are coated with various types of sealers because of their soft absorptive characteristics. Coatings provide a wear surface for residential to light commercial use.

MMSA
Materials and Methods Standards Association.

Mix
The act or process of mixing; also mixture of materials, such as mortar or concrete.

Mixer
A machine used for blending the constituents of concrete, grout, mortar, cement paste, or other mixture.

Mixer efficiency
The adequacy of a mixer in rendering a homogeneous product within a stated period; homogeneity is determinable by testing for relative differences in physical properties of samples extracted from different portions of a freshly mixed batch.

Mixer no tilting
A horizontally rotating drum mixer that charges, mixes, and discharges without tilting.

Mixer plant
See Batch plant.

Mixer, colloidal
A mixer designed to produce colloidal grout.

Mixer, horizontal shaft
A mixer having a stationary cylindrical mixing compartment, with the axis of the cylinder horizontal, and one or more rotating horizontal shafts to which mixing blades or paddles are attached.

Mixer, open-top
A truck-mounted mixer consisting of a trough or a segment of a cylindrical mixing compartment with paddles or blades rotating about the horizontal axis of the trough. (See also Mixer, horizontal shaft.)

Mixer, pan
See Mixer, vertical shaft.

Mixer, tilting
A rotating drum mixer that discharges by tilting the drum about a fixed or movable horizontal axis at right angles to the drum axis. The drum axis may be horizontal or inclined while charging and mixing.

Mixer, vertical shaft
A cylindrical or annular mixing compartment having an essentially level floor and containing one or more vertical rotating shafts to which blades or paddles are attached; the mixing compartment may be stationary or rotate about a vertical axis.

Mixing cycle
The time taken for a complete cycle in a batch mixer, i.e., the time elapsing between successive repetitions of the same operation (e.g., successive discharges of the mixer).

Mixing speed
Rotation rate of a mixer drum or of the paddles in an open-top, pan, or trough mixer, when mixing a batch; expressed in revolutions per minute (rpm), or in peripheral feet per minute of a point on the circumference at maximum diameter.

Mixing time
The period during which the constituents of a batch of concrete are mixed by

a mixer; for a stationary mixer, time is given in minutes from the completion of mixer charging until the beginning of discharge; for a truck mixer, time is given in good mixing in a specific mixing speed or expressed in terms of total revolutions at a specific mixing speed.

Mixing water
The water in freshly mixed sand-cement grout, mortar, or concrete, exclusive of any previously absorbed by the aggregate (e.g., water considered in the computation of the net water-cement ratio).

Mixture
The assembled, blended, co-mingled ingredients of mortar, concrete, or the like; or the proportions for their assembly.

Modular ratio
The ratio of modulus of elasticity of steel E, to that of concrete E, usually denoted by the symbol N.

Modulus of deformation
A concept of modulus of elasticity expressed as a function of two time variables; strain in loaded concrete as a function of the age at which the load is initially applied and of the length of time the load is sustained.

Modulus of rigidity
The ratio of unit shearing stress to the corresponding unit shearing strain; referred to as "shear modulus" and "modulus of elasticity in shear;" denoted by the symbol G. (See also Modulus of elasticity.)

Modulus of rupture
A measure of the ultimate load carrying capacity of a beam and sometimes referred to as "rupture modulus" or "rupture strength." It is calculated for apparent tensile stress in the extreme fiber of a transverse test specimen under the load that produces rupture. (See also Flexural strength.) NOTE: The actual stress in the extreme fiber is less than the apparent stress since the flexure formula employed in the calculation is valid only for stresses within the proportional limit of the material. Nevertheless, the nominal rupture strength so obtained is considered the rupture modulus.

Modulus of sub grade reaction
Ratio of load per unit area of horizontal surface (of a mass of soil) to corresponding settlement of the surface; it is determined as the slope of the secant, drawn between the point corresponding to zero settlement and a specified point on the load-settlement curve obtained from a plate load test on a soil using a 30 in. or greater diameter loading plate.

Moist room
A room in which the atmosphere is maintained at a selected temperature, usually 73.4°F (23°C), with a relative humidity of at least 98%, for the purpose of curing and storing cementitious test specimens; the facilities must be sufficient to maintain free moisture continuously on the exterior of test specimens.

Moisture expansion
An increase in dimension or bulk volume of a ceramic article caused by reaction with water or water vapor. (ASTM C242) NOTE: This reaction may occur in time at atmospheric temperature and pressure, but is expedited by exposure of the article to water or water vapor at elevated temperatures and pressures.

Moisture movement
1. The movement of moisture through a porous medium;
2. The effects of such movement on efflorescence and volume change in hardened cement paste, mortar, concrete, or rock.

Mold
1. A divider containing a cavity into which neat cement, mortar, or concrete test specimens are cast;
2. A form used in the fabrication of precast mortar or concrete units (e.g., masonry units).

Mold oil
A mineral oil that is applied to the interior surface of a clean mold, before casting concrete or mortar therein, to facilitate removal of the mold after the concrete or mortar has hardened. (See also Form oil, Bond breaker, and Release agent).

Moment distribution
A method of structural analysis for continuous beams and rigid frames whereby successive converging corrections are made to an assumed set of moments until the desired precision is obtained; also known as the Hardy Cross method.

Monochrome decoration
A single color decoration. (ASTM C242).

Monocottura (Single-Fired)
Manufacturing process that allows the simultaneous firing of the clay with the glaze producing a finished tile. A single firing.

Monolith
A body of plain or reinforced concrete cast or erected as a single integral mass or structure.

Monolithic concrete
Concrete cast with no joints other than construction.

Monolithic terrazzo
The application of a 5/8 in. (15 mm) terrazzo topping directly to a specially prepared concrete substrata, eliminating an underbed.

Monolithic topping
On flatwork: a higher quality, more serviceable topping course placed promptly after the base course has lost all slump and bleeding water.

Monomer
An organic liquid, of relatively low molecular weight, that creates a solid polymer by reacting with itself or other compounds of low molecular weight.

Monomolecular
Composed of single molecules; specifically, films that are one molecule thick. Denotes a thickness equal to one molecule (e.g., certain chemical compounds develop a "monomolecular film" over bleeding water at the surface of freshly placed concrete or mortar as a means of reducing the rate of evaporation).

Montmorillonite
See Montmorillonoid.

Montmorillonoid
A group of clay minerals, including montmorillonoite, characterized by a sheet-like internal molecular structure; consisting of extremely finely divided hydrous aluminum or magnesium silicates that swell on wetting, shrink on drying, and are subject to ion exchange.

Mortar
A mixture of cement paste and fine aggregate; in fresh concrete, the material occupying the interstices among particles of coarse aggregate; in masonry construction, mortar may contain masonry cement, or may contain hydraulic cement with lime (and possibly other admixtures) to afford greater plasticity and workability than are attainable with standard hydraulic cement mortar. (See also Cement, masonry and Masonry mortar).

Mortar bed
The layer of mortar on which tile is set. The final coat of mortar on a wall, floor or ceiling.

Mortar hoe
The mortar hoe is used for hand-mixing mortar. The best type has a perforated blade and a handle about 66” in length. The hoe should be kept clean and free of all mortar so it can be pushed and pulled easily through a box of mortar.

Mortar mixer
An electric or gas driven machine designed to mix mortar.

Mortar pumping machine
The mortar pumping machine is used with the mortar mixer. Mixed mortar is poured into the hopper, and a pneumatic gun forces the mortar through a hose. The mortar can be delivered through the hose to tile setters working as high as 13 stories above the street. Admixtures are added to the mortar as a bonder so that the mortar in the hose will not separate. The plastering gun can be used on the hose, or the hose can be used as a hoist.

Mortarboard
The mortarboard is used as a table to hold mortar. It is usually 30” square.

Mosaics
Small tile or bits of tile, stone, or glass. These are used to form a surface design or an intricate pattern.

Mounted tile
Tile assembled into units or sheets by suitable material to facilitate handling and installation. Tile may be face-mounted, back-mounted or edge-mounted. Face-mounted tile assemblies may have paper or other suitable material applied to the face of each tile, usually by water soluble adhesives so that it can be easily removed after installation and prior to grouting of the joints. Back-mounted tile assemblies may have perforated paper, fiber mesh, resin or other suitable material bonded to the back and/or edges of each tile, which becomes an integral part of the tile installation. Back-mounted and edge mounted tile assemblies shall have a sufficient exposure of tile and joints surrounding each tile to comply with bond strength requirements. Tile manufacturers must specify whether back-mounted and edge-mounted tile assemblies are suitable for installation in swimming pools, on exteriors and/or in wet areas.

Mud
A slang term for mortar.

Murals
Tile installed in a precise area of a wall or floor to provide a decorative design or picture. Glass or marble mosaic tile (tesserae) made to form a picture or design. Ceramic tile, painted and fired to form a picture or design. See Decorated and Decoration.

Muriatic acid
Hydrochloric acid (30% HCL), commercial grade.

Natural clay tile
A tile made by either the dust-pressed method or the plastic method, from clays that produce a dense body having a distinctive, slightly textured appearance. (ASTM C242).

Neat cement grout
Hydraulic cement in the non-hydrated state. Neat cement grout. A fluid mixture of hydraulic cement and water, with or without admixture; also the hardened equivalent of such mixture.

Neat cement paste
A mixture of hydraulic cement and water, both before and after setting and hardening.

Neoprene
A type of synthetic rubber with outstanding oil resistance. Can be used for quick-setting, high strength adhesives.

NIOSH
National Institute for Occupational Safety and Health

Nominal sizes
This is the approximate facial size or thickness of tile, expressed in inches or fractions of an inch, for general reference.

Non-slip tile
Tile having greater non-slip characteristics due to an abrasive admixture, abrasive particles in the surface, grooves or patterns in the surface or because of natural non-skid surface characteristics.

Non-vitreous (non-vitrified) tile
That degree of vitrification evidenced by relatively high water absorption. (ASTM C242). NOTE: The term nonvitreous generally signifies more than 10.0 percent water absorption, except for floor and wall tile which are considered nonvitreous when water absorption exceeds seven percent.

Notched back-troweling (formerly backbutter)
The spreading of a bond coat to the backs of ceramic tile just before the tile is placed.

NTCA
National Tile Contractors Association

NTMA
National Terrazzo and Mosaic Association

NSI
Natural Stone Institute

Opaque glaze
A nontransparent colored or colorless glaze. (ASTM C242).

Open time
The period of time during which the bond coat retains its ability to adhere to the tile and bond the tile to the substrate.

Orange peel
A pitted texture of a fired glaze resembling the surface of rough orange peel. (ASTM C242)

Organic adhesive
A prepared organic material, ready to use with no further addition of liquid or powders, for bonding tile to back-up material by the thinset method. Cures or sets by evaporation.

Oven ware
Ceramic whiteware for culinary oven use. (ASTM C242).

Overglaze decoration
See Decoration, overglaze.

P.S.I. or psi
Pounds per square inch, a unit measure of pressure.

Packing house tile
Similar to quarry tile but usually of greater thickness.

Paper and wire
Felt paper and wire mesh (or metal lath) that are used as a backing; for the installation of tile. Paper mounted ceramic mosaics Ceramic mosaic tiles mounted on paper. Paper is applied to face of tile in sheets approximately twelve inches wide, twenty-four inches long.

Pate dure (hard paste)
A French term designating ceramic whitewares fired at relatively high temperatures. (ASTM C242).

Pate tendre (soft paste)
A French term designating ceramic whitewares fired at relatively low temperatures. (ASTM C242).

Pavers
Unglazed porcelain or natural clay tile formed by the dust-pressed method and similar to ceramic mosaics in composition and physical properties but relatively thicker with 6 in. or more of facial area. (ASTM C242).

Peeling
See Orange peel; Shivering.

Pencil rod
Reinforcing steel rod with a diameter of 1/4".

pH
A simplified system of measuring acidity or alkalinity irrespective of the acid or alkali involved; in which neutrality is 7.0, e.g., Mineral Acid Solution is 1.0-2.8, Acetic Acid Solution or Citric Acid Solution is 3.0-4.0, Ammonia is 9.0, Lime Water is 12.0.
Physical properties of ceramic tile
Those properties as measured by ASTM tests.

Pinholes
Imperfections in the surface of a ceramic body or glaze resembling pin pricks. (ASTM C242).

Pitted
Indentations in the finished surface of individual tiles other than at the corners and edges. These are caused by sharp corners on trowels and other tools of the workmen and are different than manufacturing defects.

Pitting
Development of relatively small cavities in a surface, due to phenomena such as corrosion or cavitation, or, in concrete, localized disintegration. (See also Pop out.)

Plaster
A cementitious material or combination of cementitious material and aggregate that, when mixed with a suitable amount of water, forms a plastic mass or paste which when applied to a surface, adheres to it and subsequently hardens, preserving in a rigid state the form or texture imposed during the period of plasticity; also the placed and hardened mixture. (See also Stucco.)

Plastic cracking
Cracking that occurs in the surface of fresh concrete soon after it is placed and while it is still plastic.

Plastic flow
See Creep.

Plastic pressing
See Pressing, wet.

Plasticity
A complex property of a material involving a combination of qualities of mobility and magnitude of yield value; that property of freshly mixed cement paste concrete, or mortar which determines its resistance deformation or ease of molding.

Plasticizer
A material that increases plasticity of a cement paste, mortar, or concrete mixture.

PLI
Pounds per lineal inch.

Plumb
Perpendicular to a true level.

Plumb scratch
An additional scratch coat that has been applied to obtain a uniform setting bed on a plumb vertical plane.

Pointing mix
Mortar with a consistency of stiff paste. The mix is forcibly compressed into the tile joints where it hardens.

Poisson's ratio
The ratio of transverse (lateral) strain to the corresponding axial (longitudinal) strain resulting from uniformly distributed axial stress below the proportional limit of the material; the value will average about 0.2 for concrete and 0.25 for most metals.

Polychrome decoration
A multicolor decoration. (ASTM C242).

Polyethylene
A thermoplastic high-molecular-weight organic compound used in formulating protective coatings or, in sheet form, as a protective cover for concrete surfaces during the curing period, or to provide a temporary enclosure for construction operations.

Pop out
The breaking away of small portions of a concrete surface due to internal pressure which leaves a shallow, typically conical, depression.

Porcelain
A glazed or unglazed vitreous ceramic white ware used for technical purposes. This term designates such products as electrical, chemical, mechanical, structural, and thermal wares when they are vitreous. (See also, Alumina porcelain; Cordierite porcelain; Forsterite porcelain; Steatite porcelain; Titania porcelain; and Zircon porcelain.) (ASTM C242).

Porcelain process
The method of producing glazed ware by which a ceramic body and glaze are matured together in the same firing operation. (ASTM C242).

Porcelain tile
A ceramic mosaic tile or paver that is generally made by the dust-pressed method, of a composition resulting in a tile that is dense, fine-grained, and smooth with sharply formed face, usually impervious. (ASTM C242).

Porosity, apparent
The relationship of the open pore space to the bulk volume, expressed in percent. (ASTM C242).

Post-tensioning
A method of pre-stressing reinforced concrete in which tendons are tensioned after the concrete has hardened.

Pot life
The period of time during which a material maintains its workable properties after it has been mixed.

Pottery
All fired ceramic wares that contain clay when formed, except technical, structural and refractory products. (ASTM C242).

Precast
A concrete member that is cast and cured in other than its final position; the process of placing and finishing precast concrete.

Precast concrete
Concrete cast elsewhere than its final position.

Preload
The term used to describe mortar that has been placed and allowed to harden prior to bonding tile to it with thin-set materials.

Pregrouted tile
A surface unit consisting of an assembly of ceramic tile bonded together at their edges by a material, generally elastomeric, which seals the joints completely. Such material (grout) may fill the joint completely, or partially and may cover all, a portion or none of the back surfaces of the tiles in the sheets. The perimeter of these factory pregrouted sheets may include the entire, or part of the joint between the sheets or none at all. The term edge bonded tile is sometimes used to designate a particular type of pregrouted tile sheets having the front and back surfaces completely exposed.

Pressing
See Pressing, dry; Pressing, hot; Pressing, wet.

Pressing, dry
Forming ceramic ware in dies from powdered or granular material by direct pressure. (ASTM C242).

Pressing, hot
A jiggering process wherein a heated profile tool or plunger is employed. (ASTM C242-72)

Pressing, wet (plastic pressing)
Forming ceramic ware in dies from a plastic body by direct pressure. (ASTM C242).

Prestressed concrete
Concrete in which internal stresses of such magnitude and distribution are introduced that the tensile stresses resulting from the service loads are counteracted to a desired degree; reinforced concrete the prestress is commonly introduced by tensioning the tendons.

Pretensioning
A method of prestressing reinforced concrete in which the tendons are tensioned before the concrete has hardened.

Primary clay (residual clay)
A clay which remains geologically at its site of formation. (ASTM C242).

Process, dry (dry mix)
The method of preparation of a ceramic body wherein the constituents are blended dry, following which liquid may be added as required for subsequent processing. (ASTM C242).

Process, wet (slip process)
The method of preparation of a ceramic body wherein the constituents are blended in sufficient liquid to produce a fluid suspension for use as such or for subsequent processing. (ASTM C242).

Pumice
A highly porous and vesicular lava usually of relatively high silica content composed largely of glass drawn into approximately parallel or loosely entwined fibers, which themselves contain sealed vesicles.

Pumped concrete
Concrete which is transported through hose or pipe by means of a pump.

Pure
See Neat cement.

Pure coat
A thin coat of pure Portland cement which is used to bond tile to mortar.

Pyrophyllite
A hydrated aluminum silicate mineral of the theoretical composition Al2Si4O10(OH)2, having physical properties in the raw state resembling mineral talc. (ASTM C21)

Quality assurance
A system of procedures for selecting project or portion thereof to perform the functions intended, and assuring that these levels are obtained.

Quality control
A system of procedures and standards by which a constructor, product manufacturer, materials processor, or the like, monitors the properties of the finished work.

Quarry tile
Unglazed tile, usually 6 in. or more in surface area and 1/2 to 3/4 in. (13 to 19 mm) in thickness, made by the extrusion process from natural clay or shales. (ASTM C242).

Quartering
A method of obtaining a representative sample by dividing a circular pile of a larger sample into four equal parts and discarding opposite quarters successively until the desired size of sample is obtained.

Quicklime
Calcium oxide (CaO). (See also Lime.)

Rack
A metal grid that is used to properly space and align floor tiles.

Ragging Off
The procedure of spreading a damp cloth and pulling it over the tile surface during the tile grouting process in order to clean the tile.

Rake or rake line
The inclination from a horizontal direction.

Raked joint
A joint in a masonry wall which has the mortar raked out to a specified depth while it is only slightly hardened.

Raw glaze
A glaze compounded primarily from raw constituents, that is, containing no prefused materials. (ASTM C242).

Receptor
A metallic or nonmetallic waterproof support for a shower stall.

Reducer
A trim unit used to reduce the radius of a bullnose or a cove to another radius or to a square.

Reference lines
A pair of lines chalked on a substrate that intersect at a 90 degree angle and establish the starting point for plotting a grid of layout lines to guide in accurately setting tile.

Refractory concrete
Concrete having refractory properties, and suitable for use at high temperatures (generally about 315° to 1315° C), in which the binding agent is hydraulic cement.

Reinforced concrete
Concrete containing adequate reinforcement (prestressed or not prestressed) and designed on the assumption that the two materials act together in resisting forces.

Reinforced masonry
Unit masonry in which reinforcement is embedded in such a manner that the two materials act together in resisting forces.

Reinforcement, mesh
See Welded-wire fabric and Welded-wire fabric reinforcement.

Relative humidity
The ratio of the quantity of water vapor actually present to amount present in a saturated atmosphere at a given temperature; expressed as a percentage.

Release agent
Material used to prevent bonding of concrete to a surface. (See also Bond breaker.)

Return
The ending of a small splash wall or a wainscot at right angle to the major wall.

Rockingham ware
A semi-vitreous ware or earthenware having a brown or mottled brown bright glaze. Originated in England on the estate of the Marquis of Rockingham. (ASTM C242).

Rod saw
The rod saw is one of the newest tools used in the cutting of tile. It is a steel rod approximately 1/8" in diameter. The rod has tungsten carbide particles embedded in the surface. The rod saw is used to cut circles or irregular curves in tile.

Rodding
See Floating.

Roughing in
The act of preparing a surface by applying tar paper and metal lath (or wire mesh). Sometimes called wiring.

Rubber trowel
The rubber trowel used for grouting is a non-porous synthetic-rubber-faced float that is mounted on an aluminum back with a wood handle. This trowel is used to force material deep into tile joints and to remove excess material for a perfect finish.

Rubbing stone
A Carborundum stone that is used to smooth the rough edges of tile.

Running bond
Stretchers overlapping one another by one-half unit, with vertical joint in alternate courses.

Sag
A term used when a wall surface has developed a slide.

Salamander
A portable source of heat, customarily oil burning, used to heat an enclosure around or over newly placed concrete to prevent the concrete from freezing.

Saltillo Tile
Adobe-type tile made of clay and other natural raw materials, molded and allowed to dry. Not a fired clay product.

Sampling
The method of obtaining tile for testing from an agreed-upon lot.

Sand holes
Tiny pits in the surface of the tile.

Sandblast
A system of cutting or abrading a surface such as concrete by a stream of sand ejected from a nozzle at high speed by compressed air; often used for cleanup of horizontal construction joints or for exposure of aggregate in architectural concrete.

Sandblasting
A method of scarifying the surface of concrete or masonry to provide a bondable surface. Compressed air is used to propel a stream of wet or dry sand onto the surface.

Sander-grinder (Cutting tool)
Both sander and grinder attachment; tool used for both uninstalled and installed tile. The cutting is done dry.

Sand-Portland Cement Grout
An on-the-job mixture of Portland cement, fine graded sand, lime and water.

Saw cut
A cut in hardened concrete utilizing diamond or silicone-carbide blades or discs.

Sawed joint
A joint cut in hardened concrete, generally not to the full depth of the member, by means of special equipment.

Scaffolding
A temporary structure for the support of deck forms, cart ways, or workmen, or a combination of these such as an elevated platform for supporting workmen, tools, and materials; adjustable metal scaffolding is frequently adapted for shoring in concrete work.

Scarify
Mechanical means of roughening a surface to obtain a better bond.

Scarred faces
Surface blemishes caused by scraping or other marring of the tile.

Scratch
A mixture of Portland cement, sand, and water.

Scratch coat
The first coat of plaster or stucco applied to a surface in three-coat work; usually cross-raked or scratched to form a mechanical key with the brown coat.

Scratched
Tiles that have surface scratches (usually glazed wall tile) caused from sand, tools or rough handling.

Scratcher
Any serrated or sharply tined object that is used to roughen the surface of one coat of mortar to provide a mechanical key for the next coat.

Scratches
Any serrated or sharply tined object that is used to roughen the surface of one coat of mortar to provide a mechanical key for the next coat. See also Scarify.

Scratching
The application of a scratch coat and its combing with a scratches.

Screed
To strike off mortar laying above the desired plane or shape.

Screed guide
Firmly established grade strips or side forms for unformed concrete which will guide the strike off in producing the desired plane or shape.

Screed or Screed Strip
Strips of wood, metal, mortar or other material used as guides on which a

straightedge is worked to obtain a true mortar surface.

Sculptured tile
Tile with a decorative design of high and low areas molded into the finished fare.

Sealant
An elastomeric material that is used to fill and seal the expansion joint. This material prevents the passage of moisture and allows horizontal and lateral movement at the expansion joint.

Sealing compound
See joint sealant.

Second grade ceramic tile
Ceramic tile with appearance defects not affecting wearing or sanitary qualities.

Self-furring
Metal lath or welded wire fabric formed in the manufacturing process to include means by which the material is held away from the supporting surface, thus creating a space for "keying" of the insulating concrete, plaster, or stucco.

Self-spacing tile
Tile with lugs, spacers, or protuberances on the sides. These devices automatically space the tile for the grout joints. (SS-T-308b)

Semi-mat glaze
Having moderate gloss. (ASTM C242).

Semi-porcelain
A trade term designating semi-vitreous dinnerware. (ASTM C242).

Semi-vitreous
Less than 3 percent to 7 percent water absorption.

Set
The condition reached by a cement paste, mortar, or concrete when it has lost plasticity to an arbitrary degree, usually measured in terms of resistance to penetration or deformation; initial set refers to first stiffening; final set refers to attainment of significant rigidity; also, strain remaining after removal of stress.

Setting Bed
The layer of mortar on which the tile is set. The final coat of mortar on a wall or ceiling may also be called a setting bed.

Setting time
See Set.

Shade
The gradation of color.

Sharp sand
Coarse sand of which the particles are of angular shape.

Shear
A force that tends to slide or rupture one part of a body from another part of the body or from attached objects.

Shear test
A method of separating two materials by forcing (either by compression or tension) the interfaces to slide over the other. The force exerted is distributed over the entire bonded area at the same time. Strengths are recorded in psi.

Shear wall
A wall portion of a structural frame intended to resist lateral forces, such as earthquake, wind, and blast, acting in or parallel to the plane of the wall.

Shelf Life
The maximum period of time that an item can be stored before it is used.

Ship and galley tile
A special quarry tile having an indented pattern on the face of the tile to produce an anti-slip effect. (ASTM C242).

Shivering (peeling)
The splintering which occurs in fired glazes or other ceramic coatings due to critical compressive stress. (ASTM C242).

Shore A hardness
The reading of a material's hardness on a durometer, the scale of which is 0-100, used on elastomers as polyacrylic esters and natural rubber. Consists of a pinpoint depression into the material, the material being at least 100 mils thick. A Shore A reading of 80 equals a Shore D reading of 30.

Shore D hardness
The reading of a material's hardness on a durometer similar to the Shore A durometer, the scale of which is 0-100, used on rigid and semi-rigid materials such as polystyrene. Consists of a pinpoint depression into the material. Both the Shore A and Shore D instruments are made by the Shore Instrument Manufacturing Company, Inc., Jamaica, New York.

Shower pan
Terminology in some areas for Waterproof membrane. (CTI)

Shower receptor
The floor and side walls of the shower tip to and including the curb of the shower. (CTI) Shower receptor liner or lining. Terminology used in some areas for Waterproof membrane.

Shrinkage
The decrease in volume, or contraction, of a material by the escape of any volatile substance, or by a chemical or physical change in the material. Shrinkage crack. Crack due to restraint of shrinkage.

Shrinkage cracking
Cracking of a structure or member due to failure in tension caused by external or internal restraints as reduction in moisture content develops, or as carbonation occurs, or both.

Silica (Si02).
The common oxide of silicon usually found naturally as quartz or in complex combination with other elements as silicates. Various polymorphs and natural occurrences of silica include cristobalite, tridymite, cryptocrystalline chert, flint, chalcedony, and hydrated opal.

Silicone Grout
An engineered elastomeric grout system for interior use.

Sink Angle
Trim shape used on a drain board at the corners of the kitchen sink. This trim shape, which is AU 106, is also called a "Butterfly"

Sintered
The process of forming a solid mass of material through heat and pressure without melting to the point of liquefaction

Skid resistance
A measure of the frictional characteristics of a surface.

Skim coat
See Bond coat.

Slake
Allowing the mixtures of mortar, thinset mortar or grout to stand for a brief

period of time after the ingredients have been thoroughly combined and before the final mixing occurs. Slaking enables the moisture in the mix to penetrate lumps in the dry components, making it easier to complete the mixing procedure.

Slide
A fresh tile wall that has buckled or sagged. This condition may be caused by excessive mortar, insufficient lime in the mortar, or excessive moisture in the scratch coat. A slide also may result if the surface is slick or the mortar is too soft.

Slip (slurry)
A suspension of ceramic material in liquid. (ASTM C242).

Slip coating
A ceramic material or mixture other than a glaze, applied to a ceramic body and fired to the maturity required to develop specified characteristics. (ASTM C242).

Slip glaze
A glaze consisting primarily of a readily fusible clay or silt. (ASTM C242).

Slip process
See Process, wet.

Slip-resistant tile
Tile having greater slip-resistant characteristics due to an abrasive admixture, abrasive particles in the surface or grooves or patterns in the surface.

Slot cut
Description of a tile that has been cut to fit around pipes or switch boxes. This tile is usually in the shape of the letter U or the letter L.

Slump
A measure of consistency of freshly mixed concrete, mortar, or stucco equal to the subsidence measured.

Slump cone
A mold in the form of the lateral surface of the frustum of a cone with a base diameter of 8 in. (203 mm), top diameter 4 in. (102 mm), and height 12 in. (305 mm), used to fabricate a specimen of freshly mixed concrete for the slump test; a cone 6 in. (152 mm) high is used for tests of freshly mixed mortar and stucco.

Slump test
The procedure for measuring slump.

Slurry
A mixture of water and any finely divided insoluble material, such as Portland cement, slag, or clay in suspension.

Slush coat
A pure coat of very soft consistency. This also is called a slurry coat.

Smelt
A specific batch or lot of frit. The act of melting a batch of frit. (ASTM C 21).

Smelter
A furnace in which the raw materials of a frit batches are melted. (ASTM C 21)

Soaping tile
The method of applying a soapy film to newly tiled walls to protect them from paint and plaster during construction.

Soffit
The underside of a part or member of a structure, such as a beam, stairway, or arch.

Soil
A generic term for unconsolidated natural surface material above bedrock.

Soldier course
Oblong tile laid with the long side vertical and all joints in alignment.

Solid casting
See Casting, solid.

Solids
The dry ingredients remaining after evaporation of all volatile solvent or water. Not a fluid and not flowable.

Soluble (adj.)
Describes the property of a substance to dissolve in another and form a solution, e.g., sugar is soluble in water.

Solution
The process by which a substance (solid, liquid, or gas) is homogeneously mixed with a liquid, called the solvent, and the mixture being incapable of mechanical separation into its components. Alloys and amalgams are solutions of metals in metal; brines are solutions of a salt in water; syrups are solutions of sugars in water. Solution should not be confused or used interchangeably with such terms as dispersion, suspension or emulsion.

Solvent
In a solution, that substance which dissolves another is called the solvent. Solvent is also a common term for many liquids which are commonly used in making solutions, e.g., organic solvents, petroleum solvents, etc. Also used for thinning down a fluid, and for cleaning purposes.

Spacers
T-shaped, Y-shaped and cross shaped, they are used in installations to separate tile on walls and floors. They are manufactured in thicknesses of 1/16", 1/8", 1/4", 3/8", and 1/2".

Spacing; mix
A dry or dampened mixture of one part Portland cement and one part extra-fine sand. This mix is used as a filler in the joints of mounted ceramic mosaic tiles to keep them evenly spaced during installation.

Spall
A fragment, usually in the shape of a flake, detached from a larger mass by a blow, by the action of weather, by pressure, or by expansion within the larger mass.

Spandrel
That part of a wall between the head of a window and the sill of the window above it.

Special-purpose tile
A tile, either glazed or unglazed, made to meet or to have specific physical design or appearance characteristics such as size, thickness, shape, color, or decoration; keys or lugs on backs or sides, special resistance to staining, frost, alkalies, acids, thermal shock, physical impact, high coefficient of friction, or electrical properties. (ASTM C242).

Specific gravity
The ratio of the weight of any volume of a mass or substance to the weight of an equal volume of water at a given temperature. The specific gravity of a substance times the density of water equals the density of the substance.

Specks
Any dark dots on the tile less than 1/64 inch in diameter, and noticeable at a distance of more than three feet.

Spit out
A glaze defect of the pinhole type developed in the decorating kiln, due to evolution of minute gas bubbles from body or glaze. (ASTM C242).

Splash walls
The walls of a tile drain board or bathtub.

Split L Cut
An improper “L” cut that is made by splitting a tile instead of cutting it.

Spodumene (alpha spodumene)
A lithium mineral of the theoretical composition Li20 - A1203 - 4Si02 (monoclinic crystallization) which on heating inverts to beta spodumene, a form having very low nil thermal expansion. (ASTM C 21)

Spot Bonding
The placing of globs or daubs of mortar on the back of the tile.

Spots
Any dark dots on the face of the tile more than 1/64 inch in diameter.

Spread
The quantity of adhesive per unit area applied to an adherent, usually expressed in pounds of adhesive per thousand square feet of area.
1. Single Spread refers to application of adhesive to only one adherent.
2. Double Spread refers to application of adhesive to both adherents.

Stability
The ability to remain unchanged; equilibrium, steady, constant. Ability to restore to original condition after being disturbed by some force.

Stacking tile
A method of installation whereby glazed tiles are placed on the wall so that they are in direct contact with the adjacent tiles. The width of the joints is not maintained by the use of string or other means. The tiles may be set with either straight or broken joints.

Staining
Discoloration caused by a foreign matter chemically affecting the material itself.

Standard grade ceramic tile
Highest grade of all types of ceramic tile.

Steam curing
Curing of concrete or mortar in water vapor at atmospheric or higher pressures and at temperatures between about 100° and 420°F (40° and 215° C). (See also Autoclave curing).

Steatite porcelain
A vitreous ceramic whiteware for technical application in which magnesium metasilicate (MgO - SiO,) is the essential crystalline phase. (ASTM C242).

Steatite talc
Massive talc or the pulverized product thereof, having the general formula 3 MgO - 4SiO, H2O. (ASTM C242).

Steatite whiteware
Any ceramic whiteware in which magnesium metasilicate (NIgO - SiO,) is the essential crystalline phase. (ASTM C242).

Steel square
The steel square is one of the most important tile setting tools. The large arm of the square is 2˝ wide and 24˝ long and is called the body or blade. The smaller arm is at a 90-degree angle to the blade and is 1½˝wide and 16˝ long; it is called the tongue. The point where the outside edges of the blade and tongue join is called the heel. The surface with the manufacturer’s name is called the face; the opposite surface is called the back.

Stoneware
A vitreous or semi vitreous-ceramic ware of fine texture, made primarily from nonrefractory fire clay. (ASTM C242).

Stoning
Use of a carborundum stone to smooth rough edges caused by cutting.

Storage life
The period of time during which a materials can be stored under specified temperature conditions and remain suitable for use. Sometimes called “shelf life”.

Story pole
See Layout stick.

Straight joint
The usual style of laying tile where all the joints are in alignment.

Straightedge
A straight piece of lumber that is used to rod mortar and to align tile.

Stretcher
A masonry unit laid with its length horizontal and parallel with the face of a wall or other masonry member.

Striking joints
A process of removing excess grout from the joints by wiping with a sponge or cloth or scraping with a curved instrument.

Structural defects
Cracks or laminations in the body of the tile which detract from the aesthetic appearances and/or the structural soundness of the tile installation.

Stucco
A cement plaster used for coating exterior walls and other exterior surfaces of buildings. (See also Plaster.)

Stud
Vertical member of appropriate size (2x4 to 4x10 in.) (50x100 to 100x250 mm) and spacing (16 to 30 in.) (400 to 750 mm) to support sheathing; also a headed steel device used to anchor steel plates or shapes to concrete members.

Sub floor
A rough floor – plywood or boards – laid over joists and on which an underlayment or substrate is installed.

Substrate
The underlying support for the ceramic tile installation.

Taber Abrader
An instrument used to test the abrasion resistance of a material.

Take-off man
Someone who can read blueprints and is familiar with the specifications. This person makes tracings of special details concerning the tile work after gathering the necessary information and then estimates the labor, materials, tile quantities, and special trim shapes needed to complete the job.

Tapping tile
An inspection technique whereby a coin, key, or other small metallic object is tapped against an installed tile to determine by sound whether the tile is completely bonded to its backing. Tile setters often tap the tile with a pointing trowel to determine that a good bond has been achieved.

TCNA
Tile Council of North America

Tensile strength
The pulling force necessary to break a given specimen divided by the cross sectional area. Units given in lbs./ins. (P.S.I.). It measures the resistance of a material to stretching without rupture. Normally is not used with reference

to elastic materials which recover after elongation.

Terra cotta
Hard baked clayware, including tile, of variable color, averaging reddish red-yellow in hue and of high saturation. (CTI)

Terra sigillata
A porous, red clay ware characterized by embossed decorations of the same color and a satin-like unglazed surface. Originated on the Island of Samos. (ASTM C242).

Terrazzo concrete
See Concrete, terrazzo.

Terrazzo tile
A terrazzo surface, on a Portland cement and sand body, made by a mixture of marble chips and Portland cement and usually ground smooth. (CTI)

Tessara, tessarae
A small chip of glass or marble used in mosaic formations. (CTI)

Test
A trial, examination, observation, or evaluation used as a means of measuring a physical or chemical characteristic of a material, or a physical characteristic of a structural element or a structure.

Testing machine
A device for applying test conditions and accurately measuring results.

Testing of ceramic tile
The act of determining whether ceramic tile is acceptable. See Physical properties of ceramic tile.

Thermal break
A thermal break or thermal barrier is an element of low thermal conductivity placed in an assembly to reduce or prevent the flow of thermal energy between conductive materials.

Thermal conductivity
Ability of a material to conduct heat; physical constant for quantity of heat that passes through unit volume of a substance in unit of time when difference in temperature of two opposite faces is one degree.

Thick-bed mortar
A thick layer of mortar (more that 1/2 inch) that is used for leveling.

Thin-set
A term used to describe the bonding of tile with suitable materials applied approximately 1/8" thick. See also Dry-Set mortar.

3-4-5 Triangle
A triangle with sides in the proportion of 3:4:5, which produces one 90 degree corner. Plotting a 3-4-5 triangle is a method used to establish a pair of square reference lines on a large surface. These lines can be used to determine if the installation site is square and to create a grid of layout lines for setting tile.

Threshold, marble
A piece of marble placed beneath a door.

Tie wire
The 18-gauge galvanized wire used in construction work.

Tile
A ceramic surfacing unit, usually relatively thin in relation to facial area, made from clay or a mixture of clay and other ceramic materials, called the body of the tile, having either a glazed or unglazed face and fired above red heat in the course of manufacture to a temperature sufficiently high to produce specific physical properties and characteristics. (ASTM C242).

Tile assemblies
See definition for Mounted tile.

Tile cutter
The cutter is one of the most efficient and economical tools in the tile setting trade. A popular model is the hand-drawn tile cutting board that is adjustable.

Tile, mounted
Tile assembled into units or sheets and bonded together to facilitate handling.

Tile, back-mounted
Mounted tile with perforated paper, fiber mesh, or other suitable bonding material applied to the backs or edges of the tile so that a relatively large proportion of tile area is exposed to the setting bed.

Tile, face-mounted
Mounted tile with paper applied to the faces of the tile. The water-soluble adhesive can be removed easily prior to grouting of the joints.

Tile Nipper
Special pliers that nibble away little bites of ceramic tile to create small, irregular or curved cuts.

Tin Oxide (Sri OQ)
In finely ground form used in glazes as an opacifier.

Titania porcelain
A vitreous ceramic whiteware for technical application in which titania (TiO,) is the essential crystalline phase. (ASTM C242).

Titania whiteware
Any ceramic whiteware in which titania (TiO,) is the essential crystalline phase. (ASTM C242).

Tongue and groove
A type of lumber or precast concrete tile having mated projecting and grooved edges to provide a tight fit, abbreviated "T & G."

Trammel bar
A trammel bar, which is easy to construct, is more accurate than many other layout tools. It is used to erect perpendicular lines and to bisect angles. The tile setter can make a trammel bar from a stick of a size that is suitable for the particular job.

Trial batch
A batch of concrete prepared to establish or check proportions of the constituents.

Trimmers
Units of various shapes consisting of such items as bases, caps, corners, moldings, angles, etc. necessary or desirable to make a complete installation and to achieve sanitary purposes as well as architectural design for all types of tile work. (ASTM C242).

TROWELS

Buttering trowel
The blade of the buttering trowel is 4 1/2" wide and 7" long. It is used in buttering pure cement to tile, a method commonly used in the eastern states. The trowel is more efficient than the pointer for working on the larger and heavier tiles because more weight can be placed on it.

Flat trowel
The flat trowel is used in conjunction with the hawk for the transferring of mortar from the mortarboard to the wall or to other vertical surfaces. It is frequently used for spreading pure cement finished float coat. The flat trowel also is used for spreading mortar on floor surfaces before tiles are set.

Gauging trowel
The gauging trowel is larger than the pointing trowel but smaller than the buttering trowel. Tile setters prefer the 3-1/4” x 7” size.

Notched trowels
Notched trowels are available in the serrated, square tooth, and round designs. The teeth are made in various sizes. The correct tooth size and depth must be used to apply the thickness of bonding mortar specified. These trowels are used to apply all of the various kinds of bonding materials for ceramic tile. When the teeth become worn, the trowel has to be sharpened or replaced.

Underglaze decoration
See Decoration, underglaze. Unglazed paver tile. See Pavers.

Unglazed quarry tile
See Quarry tile.

Unglazed tile
A hard, dense tile of homogeneous composition throughout, deriving color and texture from the materials of which the body is made. The colors and characteristics of the tile are determined by the materials used in the body, the method of manufacture, and the thermal treatment. (ASTM C242).

Urethane
An elastomeric polymer with excellent chemical and water resistance. Single component (moisture cure) and 2-part (chemical cure) systems are available. Both types may be applied in a fluid state and cure (polymerize) after installation. Typical tile industry applications include sealants, caulks, waterproofing membranes, and high performance flexible adhesives.

Vapor barrier
Waterproof membrane placed under concrete floor slabs that are placed on grade.

V-Cap Trim
V-shaped trim tile used on the front edge of a countertop. The tile’s top surface is gently curved upward at the front edge to prevent water from running onto the floor.

Vellum glaze
A semi-mat glaze having a satin-like appearance. (ASTM C242).

Vertical broken joint
Style of laying tile with each vertical row of tile offset for half its length.

Vitreous
0.5 percent to 3 percent water absorption.

Vitreous (Vitrified)
That degree of verification evidenced by low water absorption. (See also Impervious; Nonvitreous; Semivitreous.) (ASTM C242).
NOTE: The term vitreous generally signifies less than .5 per rent absorption, except for floor and wall tile and low voltage electrical porcelain which are considered vitreous up to 3.0 percent water absorption.

Vitreous slip
A slip coating matured on a ceramic body, producing a vitrified surface. (ASTM C242).

Vitreous tile
Tile with water absorption of more than 0.5 percent, but not more than 3.0 percent. (ANSI A137.1-1980).

Vitrification
The progressive reduction in porosity of a ceramic composition as a result of heat treatment, or the process involved. (ASTM C242).

Vitrification range
The maturing range of a vitreous body, producing a vitrified surface. (ASTM C242).

Void
An unfilled space in a material of trapped air or other gas.

Wainscot Tile
The lower part of an interior wall when finished in tile.

Wall tile
A glazed tile with a body that is suitable for interior use and which is usually nonvitreous and is not required nor expected to withstand excessive impact.

Warpage
A concave or convex curvature of a tile so that the surface is not perfectly flat.

Water absorption
The ability to take up and retain water.

Water-cement ratio
The ratio of the amount of water, exclusive only of that absorbed by the aggregates, to the amount of cement in a concrete or mortar mixture; preferably stated as a decimal by weight.

Water level
The water level is a piece of clear plastic hose 3/8” to 1/2” in diameter and usually about 50’ in length. It is filled with water, from which all air must be removed.

Waterproof membrane
A membrane, usually made of built-up roofing, to provide a positive waterproof floor over the substrate, which is to receive a tile installation using a wire reinforced mortar bed. (CTI)

Wearing course
A topping or surface treatment to increase the resistance of a concrete pavement or slab to abrasion.

Weathering
Changes in color, texture, strength, chemical composition or other properties of a natural or artificial material due to the action of the weather.

Welded-wire fabric
A series of longitudinal and transverse wires arranged substantially at right angles to each other and welded together at all points of intersection.

Welded-wire fabric reinforcement
Welded-wire fabric in either sheets or rolls, used to reinforce mortar and concrete.

Well-graded aggregate
Aggregate having a particle size distribution which will produce maximum density, i.e., minimum void space.

Wet areas
Tile surfaces that are either soaked, saturated or regularly and frequently subjected to moisture or liquids (usually water) such as gang showers, tub enclosures, showers, laundries, saunas, steam rooms, swimming pools, hot tubs and exterior areas.

Wet pressing
See Pressing, wet. Wet process. See Process, wet.

Wetting
The thorough impregnation of a material by a liquid. The more viscous a fluid, and the higher its surface tension, the more difficult it is for the liquid to “wet” materials. Certain additives such as, water softeners, reduce surface tension

or viscosity and improve wetting properties, allowing the material to be better absorbed.

Wetting agent
A substance capable of lowering the surface tension of liquids, facilitating the wetting of solid surfaces and permitting the penetration of liquids into the capillaries.

Whiting
Calcium carbonate powder of high purity. (ASTM C242).

Wire mesh
See Welded-wire fabric.

Wood float
The wood float is sometimes used in place of the flat trowel for floating mortar. It is good for smoothing small irregularities left on the mortar bed, working the surface of the mortar before troweling on the pure coat, or compacting floor and deck mortar.

Workability
The property of freshly mixed concrete or mortar which determines the ease and homogeneity with which it can be mixed, placed, compacted, and finished.

Wrinkled sheets
Pertaining to ceramic mosaics mounted on paper. Due primarily to rough handling in shipment.

Yellow ware
A yellow semi-vitreous ware or an earthenware with a colorless clear glaze. (ASTM C242).

Zircon porcelain
A vitreous ceramic whiteware for technical application in which zircon is the essential crystalline phase. (ASTM C242).

Zircon whiteware
Any ceramic whiteware in which zircon is the essential crystalline phase. (ASTM C242).

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