INTERIOR FLOORS OVER WOOD

F250-16
STONE

• Joists 16" o.c./Plywood Subfloor
  Plywood Underlayment
• Backer Board
• Natural Stone Tile

**PORTLAND CEMENT MORTAR**

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**USE OF A MEMBRANE IS OPTIONAL. SEE MEMBRANE OPTIONS.**

Recommended Uses

• For wood substrates where thin-bed installation is desired.

Service Rating

• Residential with minimum 15/32"-thick underlayment, when stone with adequate compressive strength, flexural strength, and resistance to abrasion is used.
• Light commercial with minimum 19/32"-thick plywood underlayment, when stone with adequate compressive strength, flexural strength, and resistance to abrasion is used.

Environmental Exposure Classifications

• Res1, 2; Com1, 2.
• May be suitable for increased water exposure. See Membrane Options.
• For installations that may be exposed to staining and/or chemical attack, specify tile and grout suitable for exposure. Consult product manufacturers; see also Product Selection Guides.

Typical Weight of Tile Installation

• 10 pounds/square foot with 1/4" or 1/2" cementitious coated extruded foam backer board over 15/32" or 19/32" plywood underlayment.
• 11 pounds/square foot with 1/4" or 1/2" coated glass mat water-resistant gypsum backer board over 15/32" plywood underlayment; or with 1/4" board over 19/32" plywood underlayment.
• 11 pounds/square foot with 1/4" fiber-cement backer board over 15/32" plywood underlayment.
• 12 pounds/square foot with 1/4" or 3/8" fiber-reinforced water-resistant gypsum backer board over 15/32" plywood underlayment; or with 1/4" board over 19/32" plywood underlayment.
• 11 pounds/square foot with 1/4" fiber-cement backer board over 15/32" plywood underlayment.
• 12 pounds/square foot with 1/4" or 7/16" fiber-cement backer board over 19/32" plywood underlayment; or with 7/16" board over 15/32" plywood underlayment.
• 12 pounds/square foot with 1/4" cement backer board over 19/32" plywood underlayment.
• 12 pounds/square foot with 1/2" coated glass mat water-resistant gypsum backer board over 19/32" plywood underlayment.
• 12 pounds/square foot with 3/8" fiber-reinforced, water-resistant gypsum backer board over 19/32" plywood underlayment; or with 1/2" board over 15/32" plywood underlayment.
• 13 pounds/square foot with 1/2" cement backer board over 15/32" plywood underlayment.
• 13 pounds/square foot with 1/2" fiber-reinforced, water-resistant gypsum backer board over 19/32" plywood underlayment.
• 14 pounds/square foot with 1/2" cement backer board over 19/32" plywood underlayment.
• Does not include weight of substrate. See Appendix B for assumptions, included materials, and their individual weights.

Limitations

• Maximum joist spacing 16" on center.
• 8 x 8 or larger tile required when cementitious coated extruded foam backer board used.

Membrane Options

• Membrane options are available according to type of backer board used. See ceramic tile methods F144, F146, F170, and F175 for options.
• Specifier shall indicate if complete waterproofing is required, including if/how membrane connects to drain assembly, if base flashing is required, and treatment at other termination points.
• Check with membrane manufacturers for suitability for applicable conditions, as not all membranes are suitable for steam, high temperature, and/or chemical exposure, exterior use, use over above-ground structural slabs, use over pourable underlayments, use with radiant heat, or use over concrete with excessive moisture vapor transmission and/or alkalinity. Membrane may also affect service rating.

Requirements

• See ceramic tile methods F144, F146, F170, or F175 for requirements based on backer board type.
• Minimum grout joint width—1/16"
Preparation by Backer Board Installers

• Installation of backer board varies according to type of backer board used. See ceramic tile methods F144, F146, F170, and F175.

• Maximum allowable variation in the tile substrate—1/8" in 10' from the required plane when measured from the high points in the surface.

• Stagger backer board end and edge joints so as not to coincide with joints in subfloor. Stagger joints in adjacent rows so four corners do not come together within the same plane. Space panel ends and edges in accordance with manufacturer’s recommendations.

Materials

• Multiple options exist for membranes, mortars, grouts, and other materials and MUST BE CLEARLY SPECIFIED to be included. If not specifically indicated, optional materials are not included and mortar/grout choice defaults to minimum performance specification indicated. Consider each system component and intended use to determine minimum requirements and to specify options.

• Natural stone tile—see Natural Stone Tile Selection and Installation Guide, and consult supplier for application suitability.

• Cementitious grout—ANSI A118.6 or better or ISO CG1 or better. Consider unsanded grout for soft or semisoft stones such as limestone, travertine, marble, onyx, or similar.

• Cementitious bond coat:
  • When a waterproof membrane is not used—ANSI A118.4 or better or ISO C2S1 or better.
  • When a waterproof membrane is used—ANSI A118.4 or better or ISO C2S1 or better unless ANSI A118.1 or ISO C1 is recommended by membrane manufacturer.

• Use white for light-colored marble, limestone, and other stones where staining or darkening from grey setting materials is possible.

• Epoxy bond coat, when used—ANSI A118.3 or ISO R1 or better. See Water Sensitivity and Fiberglass Mesh Reinforced Stone in the Natural Stone Tile Selection and Installation Guide.

• Waterproof membrane, when used—ANSI A118.10.

Materials for Green/Sustainable Design

• See Green Building Standards and Green Product Selection Guide and consult manufacturers and suppliers for product sustainability and contribution to green building design.

• Consider specifying installation materials that meet ANSI A138.1, the American National Standard Specifications for Sustainable Ceramic Tiles, Glass Tiles, and Tile Installation Materials.

Preparation by Other Trades

• 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 and maximum allowable floor member live load and concentrated load deflection shall not exceed L/720. See also Substrate Requirements.

• When concentrated loads (scissor lifts, pallet jacks, forklifts, etc.) will be used on an above-ground tiled floor, the engineer and/or specifier shall specify a substrate to accommodate the concentrated loads. Owner/specifier is responsible for protecting the tilework from damage, including allowing sufficient time for installed materials to cure properly.

• Face grain of plywood subfloor and underlayment shall run perpendicular to joists.

• Underlayment—minimum 19/32" exterior-glue tongue and groove plywood with 1/8" gap between sheets.

• Maximum allowable variation in the plywood underlayment—1/8" in 10’ from the required plane, when measured from the high points in the surface. Adjacent edges of plywood sheets not to exceed 1/32" difference in height.

Movement Joint (architect must specify type of joint and show location and details on drawings)

• Movement joints—mandatory in accordance with EJ171.

Installation Specifications

• Tile—ANSI A108.5 or A108.6.

• Cementitious grout—ANSI A108.10.


• Backer board—ANSI A108.11 or manufacturer’s directions.

• Movement Joints—EJ171 and ASTM C1193.

Notes

• Underlayment fasteners should not penetrate joists below.

• As the tile size increases, there is less tolerance for variation in the substrate from the required plane. Epoxy bond coat thickness must be thin and uniform; therefore, substrate flattening may be required when epoxy bond coat is used.

• When unsanded grout is used, grout joint width must be 1/8" (nominal) or less.
Common Shower Configurations

Shower Pan Membrane at Curb/Jamb

Typical Shower Seat for Backer Board Showers

Backer Board Installation Over Shower Pan Membrane

Shower Pan Membrane SLOPED MIN. 1/4" PER FOOT TO DRAIN

CONTINUOUS BONDED WATERPROOF MEMBRANE OVER BACKER BOARD IS SLOPED MIN. 1/4" PER FOOT TO DRAIN, EXTENDS BEYOND SEATWALL INTERSECTION, AND EXTENDS BELOW TOP EDGE OF SHOWER PAN MEMBRANE

Shower Pan Membrane FOLDED UP WALLS MIN. 3" ABOVE HEIGHT OF CURB
**Submission:** call out slope of 1/2" per 1' in showers with "pebble" and other irregular tiles

**Submitter:** Dan Marvin/Mapei

**Reason for submission:**
This will allow for better drainage in this system where lack of drainage is a frequent concern. This appears to be allowed by code and ADA:

**P2709.1 Construction.**
Where a shower receptor has a finished curb threshold, it shall be not less than 1 inch (25 mm) below the sides and back of the receptor. The curb shall be not less than 2 inches (51 mm) and not more than 9 inches (229 mm) deep when measured from the top of the curb to the top of the drain. The finished floor shall slope uniformly toward the drain not less than $\frac{1}{4}$ unit vertical in 12 units horizontal (2-percent slope) nor more than $\frac{1}{2}$ unit vertical per 12 units horizontal (4-percent slope) and floor drains shall be flanged to provide a water-tight joint in the floor.

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**WET AREAS GUIDELINES**

The installation methods in this *Handbook* are rated for water exposure suitability—these ratings are listed under the Environmental Exposure Classifications subhead within each method as well as in the Environmental Exposure Classifications chart. However, this rating system cannot predict the actual amount of water any installation will be exposed to, nor compensate for water exposure exceeding the method’s rating.

The design professional must choose an installation method suitable for the amount of water the installation will be subjected to; damage can result from water exposure exceeding the method’s Environmental Exposure Classifications rating. Where the use of a waterproof membrane is optional, the rating assumes the optional membrane will not be used. If use of a waterproof membrane is intended in these applications, to provide a more water-resistant installation, it must be clearly specified.

When selecting a method, in addition to the use of the tiled area, consider maintenance practices that will be employed. For example, commercial restrooms and locker rooms typically do not require waterproofing in order to be suitable for their intended uses and normal maintenance; typically these are limited water exposure (Res2/Com2) applications. However, if such areas are to be hosed down or otherwise saturated, specify a wet area (Res3/Com3) method. Wet area installation methods typically incorporate waterproofing to contain and evacuate water and to protect building materials. The two general categories of waterproof installation methods are:

- Use of an unbonded water-containment membrane (referenced in this *Handbook* as an unbonded shower pan membrane).
- Use of a bonded waterproof membrane meeting ANSI A118.10.

A shower pan membrane is a loose laid, or unbonded, liner that is placed below a mortar bed, with the mortar bed receiving the tile. Acceptable shower pan membrane materials are listed in ANSI A108.01 Section 3.6 and include plastics such as polyvinyl chloride (PVC) and chlorinated polyethylene (CPE), metals such as lead and copper, and hot-mop systems, which employ layers of asphalt or coal-tar saturated roofing felt. Shower pan membranes connect into drains at the clamping ring level. Refer to B414, B415, B420, B426, B431, and F121 for shower pan membrane assemblies.

Bonded waterproof membranes can be sheet materials, or roll-on or trowel-on materials that dry/cure to form a waterproof membrane. These membranes also connect to drains, either at the clamping ring level, or just below the tile when an integrated bonding flange is used. Because these membranes can be bonded to various substrates, and tile is bonded to the membrane, they allow for thin-bed tile installation. Refer to B421 and B422 for bonded waterproof membrane assembly specifications.

Both systems manage water. The following are the essential requirements and considerations for designing wet areas.
**Incorporation of a Drain and Required Membrane Slope to Drain /Slope to Drain**

To fully evacuate water, shower pan membranes and bonded waterproof membranes must slope to and connect with a drain. Plumbing code typically requires membranes to be sloped a minimum of 1/4” per foot and extend at least 3” above the height of the curb or threshold. Account for the perimeter floor height required to form adequate slopes. Membranes must be installed over other horizontal surfaces in wet areas subject to deterioration, like shower seats. They must be sloped and configured so as to direct water to the membrane connected to the drain.

**Surface Slope to Drain**

For irregular or rounded finished-edge tiles, such as stone pebbles, on shower or other wet-area floor with a drain, slope finished floor surface ½” per foot to drain.

**Open Weep Holes**

The weep holes of clamping drains enable water to pass from the membrane into the plumbing system. Crushed stone or tile or other positive weep protectors placed around/over weep holes prevent their blockage.

**Membrane Connection with Drain or Integrated Bonding Flange**

To form a watertight seal, membranes must have adequate contact with the clamping ring of the drain or with the bonding area of an integrated bonding flange.

**Membrane Cuts and Penetrations**

Membranes must be protected to prevent punctures resulting from traffic on the membrane before the mortar bed is installed (for shower pan membranes) or before the tile is installed (for bonded waterproof membranes). For punctures that do occur, the membrane must be replaced or repaired according to the membrane manufacturer’s directions for repairs. Ensure the integrity of any repairs by water testing the repaired membrane.

Backer board cannot be fastened to studs lower than 3” above the finished curb height, nor fastened to the top or the inside of a curb. Backer board on shower seats must be topically waterproofed due to the use of fasteners.

**In-Corners, Out-Corners, and Seams**

Shower pan membrane in-corners should be folded not cut. For out-corners, such as where the shower curb meets the jamb, membrane manufacturers typically offer preformed out-corners to better enable wrapping of the membrane at the curb/jamb interface. For sheet-type bonded waterproof membranes applied topically, premade in-corners and out-corners enable waterproofing of corners without excessive material thickness that would result from folding. Sheet membranes in large areas are seamed, bonded, or otherwise welded together to form a continuous membrane.

**Liquid-Applied and Trowel-Applied Bonded Waterproof Membranes**

These membrane types are manufactured in the field by the installer who applies the waterproofing material. These products require a minimum wet film thickness and have specified cure/dry time requirements. Many membranes of this variety incorporate a mesh that is embedded in the wet material during installation. Mesh may be required over the entire surface to be waterproofed or only in corners and/or joints.

**Configuration of Shower Receptor Components**

When a shower pan membrane system is employed, some backer board types must be installed with the board held out of the mortar bed due to the saturation that occurs below this level. Vapor retarder membranes fastened to studs must weather-lap the shower pan membrane or flange of the tub or prefabricated shower receptor.

Whether a shower pan membrane or a bonded waterproof membrane system is used, the membrane must completely wrap the curb, and the jamb must be waterproofed to its outside edge a minimum of 3” above the curb. Curb and jamb waterproofing must be seamed together without breach to form a continuous barrier.

**Performing a Water Test**

Where complete waterproofing is required such as in showers, water testing of the membrane, by the installing contractor, is recommended and may be required by applicable plumbing code.
**Spot-Bonding Epoxy**

Spot-bonding epoxy is a multi-component high-strength epoxy adhesive designed for spot-bonding ceramic tile and stone.

Refer to ANSI A118.3. For applicable ISO material specifications, see ISO R criteria.

**Organic Adhesive**

Organic adhesive is a prepared organic material for interior use only, ready to use with no further addition of liquid or powder, which cures or sets by evaporation. Organic adhesives are suitable for setting ceramic tile on floors, walls, and countertops, where surfaces are appropriate and properly prepared in accordance with adhesive manufacturer’s directions. Adhesives are applied in one thin layer with a trowel, first using the flat edge for continuous coverage and then the notched edge for uniform thickness. Where leveling or truing is required, an underlayment is used.

Adhesives are not suitable for swimming pools, exteriors, or areas exposed to temperatures exceeding 140ºF. They supply some flexibility to the tile facing. Bond strength varies greatly among the numerous brands available. Solvents in some adhesives are irritating to some persons, and some adhesives are flammable.

Complete installation and material specifications are contained in ANSI A108.4 and ANSI A136.1. For applicable ISO material specifications, see ISO D criteria.

Submission: Proposal to remove spot bonding epoxy methods and references

Submitter: Dan Marvin/Mapei

Reason for submission: This can lead to ‘ghosting’, water intrusion issues and leads to the inevitable ‘well TCNA has it as a method in the handbook’ discussion even when it’s a very specific method for walls over masonry with epoxy only. I think it causes more confusion than clarification.
W215-16

- Masonry or Concrete
- Spot-Bonding Epoxy
- Ceramic Tile

Recommended Uses
- For clean, sound interior walls of masonry or concrete where large format tiles are specified.

Environmental Exposure Classifications
- Res1; Com1.
- For installations that may be exposed to staining, specify tile and grout suitable for exposure. Consult product manufacturers; see also Product Selection Guides.
- For installations that may be exposed to mild chemical attack, specify epoxy grout and tile suitable for exposure. Consult product manufacturers; see also Product Selection Guides.

Limitations
- Will not withstand impact.
- Not for cracked or coated surfaces.

Requirements
- Epoxy must be recommended by the manufacturer for spot-bonding.
- Follow epoxy manufacturer’s coverage requirements.
- Masonry or concrete to be well-cured, dimensionally stable, and free of cracks, waxy or oily films, and curing compounds.
- Concrete may require bush-hammering or sandblasting to facilitate bonding.

Materials
- Multiple options exist for membranes, mortars, grouts, and other materials and MUST BE CLEARLY SPECIFIED to be included. If not specifically indicated, optional materials are not included and mortar/grout choice defaults to minimum performance specification indicated. Consider each system component and intended use to determine minimum requirements and to specify options.
  - Ceramic tile—ANSI A137.1.
  - Cementitious grout—ANSI A118.6 or better or ISO CG1 or better.
  - Epoxy grout, when used—ANSI A118.3 or ISO RG.
  - Sealant, when used as grout—ASTM C920.
  - Spot-bonding epoxy adhesive—epoxy recommended by manufacturer for spot-bonding.

Materials for Green/Sustainable Design
- See Green Building Standards and Green Product Selection Guide and consult manufacturers and suppliers for product sustainability and contribution to green building design.
- Consider specifying tile and installation materials that meet ANSI A138.1, the American National Standard Specifications for Sustainable Ceramic Tiles, Glass Tiles, and Tile Installation Materials.

Preparation by Other Trades
- Maximum allowable variation in the tile substrate—1/4" in 10' from the required plane.

Movement Joint (architect must specify type of joint and show location and details on drawings)
- Movement joints—mandatory according to EJ171.

Installation Specifications
- Tile—epoxy manufacturer’s directions.
- Cementitious grout—ANSI A108.10.
- Epoxy grout—ANSI A108.6.
- Sealant—follow sealant and epoxy manufacturer’s instructions for using sealant as grout.
- Movement Joints—EJ171 and ASTM C1193.
INTERIOR WALLS OVER WOOD OR METAL STUDS

W260-16
• Wood or Metal Studs
• Cement Backer Board
• Spot-Bonding Epoxy
• Ceramic Tile

Recommended Uses
• For interior walls where cement backer board is the tile backer and large format tiles are specified.

Environmental Exposure Classifications
• Res1; Com1.
  • For installations that may be exposed to staining, specify tile and grout suitable for exposure. Consult product manufacturers; see also Product Selection Guides.
  • For installations that may be exposed to mild chemical attack, specify epoxy grout and tile suitable for exposure. Consult product manufacturers; see also Product Selection Guides.

Limitations
• Will not withstand impact.
• Maximum stud spacing 16” on center.

Requirements
• Epoxy must be recommended by the manufacturer for spot-bonding.
• Follow epoxy manufacturer’s coverage requirements.
• Wood studs—dry and well-braced, minimum depth 3-1/2”.
• Metal studs—well-braced, 20 gauge (0.033”) or heavier, minimum depth 3-1/2” for residential applications or 3-5/8” for commercial applications.
• Surface of units—clean and free of dirt, dust, paint, and oily film.

Preparation by Backer Board Installers
• Maximum allowable variation in the tile substrate—1/4” in 10’ from the required plane.
• Horizontal joints—1/8” spacing filled solid and taped with latex-portland cement mortar and 2” alkali-resistant glass fiber mesh tape.
• Vertical joints—fill any space and tape with latex-portland cement mortar and 2” alkali-resistant glass fiber mesh tape.
• Corners—leave space between backer units. Tape joints using skim coat of latex-portland cement mortar, but do not fill.
• Center backer board end or edge joints on framing and stagger joints in adjacent rows so four corners do not come together within the same plane. Space panel ends and edges in accordance with manufacturer’s recommendations.

Materials
• Multiple options exist for membranes, mortars, grouts, and other materials and MUST BE CLEARLY SPECIFIED to be included. If not specifically indicated, optional materials are not included and mortar/grout choice defaults to minimum performance specification indicated. Consider each system component and intended use to determine minimum requirements and to specify options.
  • Ceramic tile—ANSI A137.1.
  • Cementitious grout—ANSI A118.6 or better or ISO CG1 or better.
  • Epoxy grout, when used—ANSI A118.3 or ISO RG.
  • Sealant, when used as grout—ASTM C920.
  • Spot-bonding epoxy adhesive—epoxy recommended by manufacturer for spot-bonding.
  • Cement backer board—ANSI A118.9 or ASTM C1325 (Type B).
  • Fasteners—noncorrosive and nonoxidizing.
  • 2” alkali-resistant glass fiber mesh tape.
  • Cementitious mortar (for taping joints)—ANSI A118.4 or better or ISO C2 or better.
  • Metal studs—ASTM C645.

Materials for Green/Sustainable Design
• See Green Building Standards and Green Product Selection Guide and consult manufacturers and suppliers for product sustainability and contribution to green building design.
• Consider specifying tile and installation materials that meet ANSI A138.1, the American National Standard Specifications for Sustainable Ceramic Tiles, Glass Tiles, and Tile Installation Materials.

Preparation by Other Trades
• Wall framing shall meet the general framing requirements of ANSI A108.11-4.0–4.3.

Movement Joint (architect must specify type of joint and show location and details on drawings)
• Movement joints—mandatory according to EJ171.
Installation Specifications

- Cement-backer board—ANSI A108.11.
- Tile—epoxy manufacturer’s directions.
- Cementitious grout—ANSI A108.10.
- Epoxy grout—ANSI A108.6.
- Sealant—sealant and epoxy manufacturer’s directions for using sealant as grout.
- Movement Joints—EJ171 and ASTM C1193.
W215-16
STONE

- Masonry or Concrete
- Spot-Bonding Epoxy
- Natural Stone Tile

Recommended Uses
- For clean, sound interior walls of masonry or concrete where large-format tiles are specified.

Environmental Exposure Classifications
- Res1; Com1.
- For installations that may be exposed to staining and/or chemical attack, specify tile and grout suitable for exposure. Consult product manufacturers; see also Product Selection Guides.

Limitations
- Will not withstand impact.
- Not for cracked or coated surfaces.

Requirements
- Epoxy must be recommended by the manufacturer for spot-bonding.
- Follow epoxy manufacturer’s coverage requirements.
- Masonry or concrete to be well-cured, dimensionally stable, and free of cracks, waxy or oily films, and curing compounds.
- Concrete may require bush-hammering or sandblasting to facilitate bonding.
- Minimum grout joint width—1/16”

Materials
- Multiple options exist for membranes, mortars, grouts, and other materials and MUST BE CLEARLY SPECIFIED to be included. If not specifically indicated, optional materials are not included and mortar/grout choice defaults to minimum performance specification indicated. Consider each system component and intended use to determine minimum requirements and to specify options.
- Natural stone tile—see Natural Stone Tile Selection and Installation Guide, and consult supplier for application suitability.
- Cementitious grout—ANSI A118.6 or better or ISO CG1 or better. Consider unsanded grout for soft or semisoft stones such as limestone, travertine, marble, onyx, or similar.
- Sealant, when used as grout—ASTM C920.
- Spot bonding epoxy adhesive—epoxy recommended by manufacturer for spot-bonding.

Materials for Green/Sustainable Design
- See Green Building Standards and Green Product Selection Guide and consult manufacturers and suppliers for product sustainability and contribution to green building design.
- Consider specifying installation materials that meet ANSI A138.1, the American National Standard Specifications for Sustainable Ceramic Tiles, Glass Tiles, and Tile Installation Materials.

Preparation by Other Trades
- Maximum allowable variation in the tile substrate—1/4” in 10’ from the required plane.

Movement Joint (architect must specify type of joint and show location and details on drawings)
- Movement joints—mandatory according to EJ171.

Installation Specifications
- Tile—epoxy manufacturer’s directions.
- Cementitious grout—ANSI A108.10.
- Sealant—follow sealant and epoxy manufacturer’s directions.
- Movement Joints—EJ171 and ASTM C1193.

Notes
- When unsanded grout is used, grout joint width must be 1/8” (nominal) or less.
W260-16
STONE

- Wood or Metal Studs
- Cement Backer Board
- Spot-Bonding Epoxy
- Natural Stone Tile

**Recommended Uses**
- For interior walls where cement backer board is the tile backer and large format tiles are specified.

**Environmental Exposure Classifications**
- Res1; Com1.
- For installations that may be exposed to staining and/or chemical attack, specify tile and grout suitable for exposure. Consult product manufacturers; see also Product Selection Guides.

**Limitations**
- Will not withstand impact.
- Maximum stud spacing 16" on center.

**Requirements**
- Epoxy must be recommended by the manufacturer for spot-bonding.
- Follow epoxy manufacturer’s coverage requirements.
- Wood studs—dry and well-braced, minimum depth 3-1/2".
- Metal studs—well-braced; 20 gauge (0.033") or heavier; minimum depth 3-1/2" for residential applications or 3-5/8" for commercial applications.
- Surface of units—clean and free of dirt, dust, paint, and oily film.
- Minimum grout joint width—1/16".

**Preparation by Backer Board Installers**
- Maximum allowable variation in the tile substrate—1/4" in 10‘ from the required plane.
- Horizontal joints—1/8" spacing filled solid and taped with latex-Portland cement mortar and 2" alkali-resistant glass fiber mesh tape.
- Vertical joints—fill any space and tape with latex-Portland cement mortar and 2" alkali-resistant glass fiber mesh tape.
- Corners—leave space between backer units. Tape joints using skim coat of latex-Portland cement mortar, but do not fill.
- Center backer board end or edge joints on framing and stagger joints in adjacent rows so four corners do not come together within the same plane. Space panel ends and edges in accordance with manufacturer’s recommendations.

**Materials**
- Multiple options exist for membranes, mortars, grouts, and other materials and MUST BE CLEARLY SPECIFIED to be included. If not specifically indicated, optional materials are not included and mortar/grout choice defaults to minimum performance specification indicated. Consider each system component and intended use to determine minimum requirements and to specify options.
- Natural stone tile—see Natural Stone Tile Selection and Installation Guide, and consult supplier for application suitability.
- Cementitious grout—ANSI A118.6 or better or ISO CG1 or better. Consider unsanded grout for soft or semisoft stones such as limestone, travertine, marble, onyx, or similar.
- Sealant, when used as grout—ASTM C920.
- Spot-bonding epoxy adhesive—epoxy recommended by manufacturer for spot bonding.
- Cement backer board—ANSI A118.9 or ASTM C1325 (Type B).
- Fasteners—noncorrosive and nonoxidizing.
- 2” alkali-resistant glass fiber mesh tape.
- Cementitious mortar (for taping joints)—ANSI A118.4 or better or ISO C2 or better.
- Metal studs—ASTM C645.

**Materials for Green/Sustainable Design**
- See Green Building Standards and Green Product Selection Guide and consult manufacturers and suppliers for product sustainability and contribution to green building design.
- Consider specifying installation materials that meet ANSI A138.1, the American National Standard Specifications for Sustainable Ceramic Tiles, Glass Tiles, and Tile Installation Materials.

**Preparation by Other Trades**
- Wall framing shall meet the general framing requirements of ANSI A108.11-4.0-4.3.

**Movement Joint (architect must specify type of joint and show location and details on drawings)**
- Movement joints—mandatory according to EJ171.
Installation Specifications
- Cement backer board—ANSI A108.11.
- Tile—epoxy manufacturer’s directions.
- Cementitious grout—ANSI A108.10.
- Sealant—sealant and epoxy manufacturer’s instructions for using sealant as grout.
- Movement Joints—EJ171 and ASTM C1193.

Notes
- When unsanded grout is used, grout joint width must be 1/8” (nominal) or less.
Recommended Uses
- For interior and exterior pools and water features with tanks of concrete, shotcrete, *gunite*, *CMU*, etc., that are not watertight.

Environmental Exposure Classifications
- Res 3, 4, 6, 7; Com 3, 4, 6, 7.

Requirements
- Pool tank and water feature construction must be reinforced concrete, shotcrete, *gunite*, *CMU* etc.
- Cure cement mortar beds a minimum of 7 days prior to application of tile or bonded waterproof membrane (A118.10).
- Tile bond coat coverage—minimum 95% contact with tile and substrate.
- Pool tank surface must be free of grease, oil, wax, curing compounds, or other bond inhibiting coatings; pressure wash/mechanically scarify if necessary.

Materials
- Multiple options exist for membranes, mortars, grouts, and other materials and MUST BE CLEARLY SPECIFIED to be included. If not specifically indicated, optional materials are not included and mortar/grout choice defaults to minimum performance specification indicated. Consider each system component and intended use to determine minimum requirements and to specify options.
- Ceramic tile—ANSI A137.1 and recommended in writing by manufacturer for use in pools and other similar water features. Tile not covered by A137.1 should be recommended in writing by the manufacturer for use in pools and water features.
- Glass tile, when used—ANSI A137.2 and recommended in writing by manufacturer for use in pools and water features. Tile not covered by A137.2 should be recommended in writing by the manufacturer for use in pools and water features; see also Glass Tile Selection and Installation Guide, and consult tile manufacturer for environmental exposure.
classification recommendations. Not all glass tiles are suitable.

- Cementitious grout—ANSI A118.6 or better or ISO CG1 or better. Blue, green, and red grouts may not be suitable for submerged applications; consult manufacturer for application suitability.
- Epoxy grout, when used—ANSI A118.3 or ISO RG. Epoxy grout may be affected by UV exposure; consult manufacturer for application suitability.
- Cementitious bond coat:
  - When a waterproof membrane is not used on the face of the mortar bed—ANSI A118.15 or better or ISO C2S1 or better.
  - When a waterproof membrane is used on the face of the mortar bed—ANSI A118.15 or better or ISO C2S1 or better unless ANSI A118.1 or ISO C1 is recommended by membrane manufacturer.
  - When glass tile is used, specify mortar designated by tile and mortar manufacturers. **Bond coat color will impact the final appearance of translucent glass tile. Specifier shall confirm bond coat color is acceptable.**
- Epoxy bond coat, when used - ANSI A118.3 or better or ISO R2 or better
  - When glass tile is used, specify epoxy bond coat designated by tile and bond coat manufacturer. Bond coat color will impact the final appearance of translucent glass tile. Specifier shall confirm bond coat color is acceptable.
- Waterproof membrane on top of the mortar bed, when used—ANSI A118.10.
- Walls—cement mortar bed/scratch coat 1 part portland cement (ASTM C150) to 4 parts damp sand (ASTM C144) by volume.
- Floors—cement mortar bed 1 part portland cement (ASTM C150) to 4 to 5 parts damp sand (ASTM C144) by volume mixed with water to a consistency and workability to allow maximum compaction during tamping (ANSI A108.1A-2.2.2).
- Mortar bed bond coat—latex-portland cement mortar meeting ANSI A118.4 or better or ISO C2S1 or better.
- Cementitious waterproofing—recommended by manufacturer for use in positive and negative hydrostatic pressure applications and swimming pools. Must be able to support the weight of the bonded mortar bed and tile assembly; consult manufacturer for application suitability.
- Flexible Sealant—ASTM C920 and suitable for pool applications. Consult manufacturer.

**Materials for Green/Sustainable Design**
- See Green Building Standards and Green Product Selection Guide and consult manufacturers and suppliers for product sustainability and contribution to green building design.
- Consider specifying tile and installation materials that meet ANSI A138.1, the **American National Standard Specifications for Sustainable Ceramic Tiles, Glass Tiles, and Tile Installation Materials**.

**Membrane Options**
- A waterproof membrane (A118.10) may be specified for use over the mortar bed, which may be beneficial in freeze-thaw climates or when additional resistance to positive hydrostatic pressure is required.
- Confirm membrane suitability for specified application with manufacturer. Not all membranes are suitable for partial coverage applications (such as waterlines), exterior use, submersion, high-temperature, or chemical exposure.
- When glass tile is used, consult glass tile manufacturer for membrane options and recommendations.

**Preparation by Other Trades**
- Deviations from dimensions, contours, or slopes in concrete, shotcrete, or CMU gunite tank must not exceed 1/2" or encroach on the required minimum thickness of the mortar bed and tilework in order to provide exact dimensional requirements in length and width and specified tolerances.
- When applicable, based on the soil report, concrete tank must be engineered and constructed to support
the tile installation and meet the requirements of the ANSI/APSP Pool and Spa Standards 1-5 and applicable building codes.

- Concrete tank to be finished per cementitious waterproofing manufacturer's requirements.
- Concrete tank to be made watertight with cementitious waterproofing.
- A penetrating colloidal silicate may be applied to the pool tank prior to application of cementitious waterproofing to densify the tank and reduce the migration of water soluble mineral compounds (efflorescence). Consult penetrating colloidal silicate manufacturer for recommendations.
- For pools and water features completely covered with tile, a water fill test (performed by the waterproofing contractor) after the cementitious waterproofing has been applied and cured per manufacturer's directions is required.
- Defects in the tank (i.e., active water leaks, cracks, unsound concrete, shotcrete, gunite, CMU etc.) must be repaired prior to the commencement of tilework.

Movement Joint (architect must show type of joint and show location and details on drawings)
- Directly over any joints in the concrete tank (EJ 171A or EJ 171E).
- In tilework on 8' to 12' centers (EJ 171F).
- Perimeter joint between the tile assembly and coping/decking (EJ 171I).
- Perimeter joint at all changes in plane and at all restraining abutments (EJ 171G).
- When glass tile is used, adhere to more frequent placement recommendations within the ranges listed in EJ 171.

Installation Specifications
- Tile—ANSI A108.5 (with cementitious bond coat) or ANSI A108.6 (with epoxy bond coat).
- Glass tile—ANSI A108.14, .15, .16, or manufacturer's directions.
- Cementitious grout—ANSI A108.10.
- Epoxy grout—ANSI A108.6.
- Cementitious waterproofing—manufacturer's directions.

- Movement Joints—EJ 171 and ASTM C1193.
- Penetrating Colloidal Silicate—manufacturer's directions

Notes
- Some tile, glazes, backings, and mounting systems are not suitable for exterior or submerged applications.
- Not all bonding mortars are suitable for exterior or submerged use.
- In freeze-thaw climates, additional waterproofing consideration may be required to prevent cement mortar bed moisture intrusion.
- Mortar bed performance may be improved by the use of modified mortar; consult manufacturer for recommendations.
- When glass tile is used, see Glass Tile Selection and Installation Guide, and consult manufacturer for recommendations and requirements.
- Pool water chemistry and balance will impact the appearance and performance/serviceability of the tile and installation materials. It should be monitored/maintained by a pool maintenance professional. Refer to ANSI APSP-5 for residential or APSP-11 for water quality in public pools and spas for pool start-up and maintenance guidelines.
- Consult setting material and grout manufacturers for minimum cure times prior to submersion.
- Pool may need to be protected from direct sunlight, excessive heat, wind, precipitation, and freezing during substrate preparation, installation, and curing.
ADDITIONAL PRODUCTS USED IN TILE INSTALLATIONS

**Exterior Ceramic Tile Panels**
To reduce construction time, these prefabricated, lightweight, custom-built panels are shipped to the construction site and attached to the building by welding or mechanical fasteners.

Panel size, shape, and thickness are determined by building design. Size, spacing, and gauge of the steel stud framework are also dependent on design but may be related to the climatic conditions of the building location.

Manufacturers of tile, mortars, and backing materials and regional contractor associations can supply guide specifications for panel construction. However, the ceramic tile installation is usually done in accordance with W201 (from the membrane out) or W244E (bonding directly to solid backing attached to the studs). Tile to be installed per ANSI specifications.

**Integrated Bonding Flange**
An integrated bonding flange is designed to provide a large contact area at the top of the drain assembly, which will allow ample surface adhesion to thin, load bearing, bondable waterproof membranes. Drain assemblies of this type are constructed in such a way that the waterproof membrane is bonded to the top of the substrate rather than below it. All drains must comply with local code.

**Profiles**
Floor profiles, wall profiles, transition profiles, cove profiles, and preformed joint profiles may be incorporated into a tile installation where suitable. Profiles are available in various materials, finishes, colors, and heights. Select the correct material considering traffic and environmental conditions (water exposure, chemical exposure, etc.) and the correct height considering the tile thickness and setting bed thickness.

These products are not characterized by ASTM, ANSI, or ISO product standards. Consult manufacturer for all performance and installation criteria.

**Reduced Thickness Porcelain Tiles**
Reduced thickness porcelain tiles, or thin tiles, are now in the marketplace with properties different from traditional ceramic tiles. Several manufacturing technologies exist, producing tiles in traditional sizes up to tiles, or “panels,” as large as 5 feet by 10 feet and less than 1/4” thick (nominally).

Depending on the thickness, while typically meeting ISO 13006 modulus of rupture requirements (one measurement of strength), many of these thinner tiles do not meet ANSI A137.1 breaking strength requirements and require handling and installation that take the lower breaking strength into consideration. Not all manufacturers recommend their tiles for all substrates. Check with the manufacturer for recommended applications, and whether flooring applications are supported.

Some reduced thickness tiles employ reinforcement on the back changing the physical properties of the tiles, adding impact resistance, raising the breaking strength (although in this category, the breaking strength after reinforcement can still be below the ANSI A137.1 threshold), and reducing crack propagation. There are a variety of technologies employed and such reinforcement requires additional consideration when selecting appropriate setting materials.

In general, specialized tools, equipment, thin-bed mortar, and training are required for the successful installation of reduced thickness tiles. With larger tiles, flattening the substrate before installation may be required as stringent substrate and installation requirements apply, especially in flooring applications. Special care may be required to achieve sufficient mortar contact between the tile and substrate, especially near the grout joints.

These products are not characterized by ASTM, ANSI or ISO product performance or installation standards. Consult manufacturer for all substrate, performance and installation criteria. Some manufacturers may require the use of pre-qualified installers.

**Structural Ribbed Self-Supporting Boards (SRSB)**
Structural ribbed self-supporting boards (SRSB) are a pultruded, lightweight board manufactured of a composite dovetailed rib system, integrated and adhered to a fiberglass backing. The boards are engineered to be structural and are attached directly to the wood or steel joist system of an exterior deck or balcony of residential applications or interior joists. By eliminating the wood deck boards or a plywood substrate, the deck and the tiled surface are no longer subject to wood swelling and shrinking due to humidity and moisture. The dovetailed cavities are filled with mortar and to establish the tile substrate. A waterproof membrane conforming to ANSI A118.10 is required for all installations subject to freeze/thaw conditions.

These products are not characterized by ASTM, ANSI, or ISO product standards. Consult manufacturer for all performance and installation criteria.

**Thresholds**
FXXX-17

- Roof Deck or Balcony
- Structural Ribbed Self-Supporting Boards (SRSB) Filled with Portland Cement Mortar
- Ceramic Tile

*Use of a waterproof membrane is required in freeze/thaw climates.

See Membrane Options.

Recommended Uses:
- For residential balconies and decks over unoccupied space, constructed of a joist system sloped min. 1/4” per foot.

Service Rating:
- Light

Environmental Classifications:
- Res6; Com6
- For installations that may be exposed to staining, specify tile and grout suitable for exposure. Consult product manufacturers; see also Product Selection Guides.

Typical Weight of Tile Installation
- 5 pounds/square foot.
- Does not include weight of substrate (mortar-filled SRSB). See Appendix B for assumptions, included materials, and their individual weights.

Limitations:
- 12” x 12” and larger tile only
- Maximum joist spacing 16” on center.
- Where the installation will be subjected to freeze-thaw cycles, snow and ice accumulation, and/or snow melting chemicals, degradation can occur over time.
- Requires additional consideration by design professional to accommodate movement and/or deflection. Setting materials with improved bond strength and deformability are required.

Membrane Options
- A waterproof membrane (A118.10) is required for installations that will be exposed to freeze/thaw cycling. When used, membrane flashing is required.
- Specifier shall indicate if complete waterproofing is required, including if/how membrane connects to drain assembly, if base flashing is required, and treatment at other termination points.
- Check with membrane manufacturers for suitability for applicable conditions, as not all membranes are suitable for steam, high temperature, and/or chemical exposure, exterior use, use over above-ground structural slabs, use over pourable underlayments, use with radiant heat, or use over concrete with excessive moisture vapor transmission and/or alkalinity. Membrane may also affect service rating.
Requirements:
- Above-ground installations are inherently more susceptible to vibration and deflection. Grout and mortar manufacturers to warrant product suitability.
- Mortar bed thickness—screed fill channels of SRSB boards flush to top of ribs and allow to cure 24 hours.
- The ends of SRSB must be fully supported. Cantilevering is not permitted.

Preparation by Other Trades:
- For decks with 8 foot and longer joists, cross bracing may be needed between joists to prevent racking. Consult SRSB manufacturer.
- Floor systems 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.
- Maximum allowable substrate deflection under live load not to exceed l/360. See also Substrate Requirements.
- When concentrated loads (scissor lifts, pallet jacks, automobiles, forklifts, etc.) will be used on an above-ground tiled floor, the engineer and/or specifier shall specify a substrate to accommodate the concentrated loads.
- Owner/specifier is responsible for protecting the tilework from damage, including allowing sufficient time for installed materials to cure properly.
- Maximum allowable variation in the joist system—¼” in 10'-0 and 1/16” in 1'-0” from the required plane.
- Slope joist system min. ¼” per foot. Flat deck with poor or no drainage will not perform well.

Materials:
- Multiple options exist for membranes, mortars, grouts, and other materials and MUST BE CLEARLY SPECIFIED to be included. If not specifically indicated, optional materials are not included and grout/mortar choice defaults to minimum performance specification indicated.
- Consider each system component and intended use to determine minimum requirements and to specify options.
- Ceramic tile—ANSI A137.1
- Cementitious grout—ANSI A118.7 or better or ISO CG2 or better.
- Cementitious bond coat:
  - Must be recommended by manufacturer for above ground use.
  - When a membrane is not used—ANSI A118.15 or better or ISO C2S1 or better.
  - When a waterproof membrane is used—ANSI A118.15 or better or ISO C2S1 or better unless ANSI A118.1 or ISO C1 is recommended by membrane manufacturer.
- Waterproof membrane, when used—ANSI A118.10
- Waterproof membrane flashing, when used—per applicable building codes
- Mortar bed—ANSI A108.1A
- Structural ribbed self-supporting boards—recommended by manufacturer for intended use or application and meeting the following requirements:
  - Structural ribbed self-supporting boards—recommended by manufacturer for intended use or application and meeting the following requirements:
    - water absorption < 3% when tested per ASTM D570
    - passes 300 cycles when tested per ASTM C67, Section 9
    - flexural strength ≥ 2,600 psf when tested per ASTM D790
    - direct screw withdrawal resistance (using SRSB manufacturer’s recommended fastener) ≥ 250 psf when tested per ASTM D1037, Section 16
    - passes Robinson Floor Test (ASTM C627) cycles 1-10 when tested with standard 12”x12” ANSI A137.1 pressed floor tile, ANSI A118.6 grout, and ANSI A118.4 mortar; and joists spaced 16” o.c.
    - passes Robinson Floor Test (ASTM C627) cycles 1-10 when tested with standard 12”x12” ANSI A137.1 pressed floor tile, ANSI A118.6 grout, and ANSI A118.4 mortar; joists spaced 16” o.c.; and modified to accommodate a 14’ suspended floor assembly
    - Receives flame spread and smoke development indices of 0-0-0-0 when exposed to fire, when tested per ASTM E84.
- Fasteners—1-5/8” pan head screws, non-corrosive and non-oxidizing.
Materials for Green/Sustainable Design
● See Green Building Standards and Green Product Selection Guide and consult manufacturers and suppliers for product sustainability and contribution to green building design.
● Consider specifying tile and installation materials that meet ANSI A138.1, the American National Standard Specifications for Sustainable Ceramic Tiles, Glass Tiles, and Tile Installation Materials.

Movement Joint (architect must specify type of joint and show location and details on drawing):
● Movement joints—mandatory according to EJ171. For above-ground installations additional movement joints are required.
● Do not extend movement joints through SRSB boards.

Installation Specifications:
● Tile—ANSI A108.5
● Cementitious grout—ANSI A108.10.
● Mortar bed—ANSI A108.1B
● SRSB—manufacturer’s directions
● Movement Joints—EJ171 and ASTM C1193.

Notes:
● State and local building codes for exterior deck construction, membrane requirements, and membrane flashing requirements vary; check applicable codes for requirements.
● Not all bonding mortars are suitable for exterior use.
● Not all mortars, grouts, and membranes are suitable for above-ground use. Check manufacturer recommendations.
● Protection of installation may be required to prevent premature exposure of setting materials to moisture.
● Some substrate materials used in wet areas are subject to deterioration from moisture. See ANSI A108.01-2.4.
● Flush cove base shown, see Using the TCNA Handbook for Specification Writing for additional base options.
FXXX-17 STONE

- Roof Deck or Balcony
- Structural Ribbed Self-Supporting Boards (SRSB) Filled with Portland Cement Mortar
- Natural Stone Tile

*Use of a waterproof membrane is required in freeze/thaw climates.

See Membrane Options.

Environmental Classifications:
- Res6; Com6
- For installations that may be exposed to staining, specify tile and grout suitable for exposure. Consult product manufacturers; see also Product Selection Guides.

Typical Weight of Tile Installation
- 7 pounds/square foot.
- Does not include weight of substrate (mortar-filled SRSB). See Appendix B for assumptions, included materials, and their individual weights.

Limitations:
- 12” x 12” and larger tile only
- Maximum joist spacing 12” on center.
- Where the installation will be subjected to freeze-thaw cycles, snow and ice accumulation, and/or snow melting chemicals, degradation can occur over time.
- Requires additional consideration by design professional to accommodate movement and/or deflection. Setting materials with improved bond strength and deformability are required.

Membrane Options
- A waterproof membrane (A118.10) is required for installations that will be exposed to freeze/thaw cycling. When used, membrane flashing is required.
- Specifier shall indicate if complete waterproofing is required, including if/how membrane connects to drain assembly, if base flashing is required, and treatment at other termination points.
- Check with membrane manufacturers for suitability for applicable conditions, as not all membranes are suitable for steam, high temperature, and/or chemical exposure, exterior use, use over above-ground structural slabs, use over pourable underlayments, use with radiant heat, or use over concrete with excessive moisture vapor transmission and/or alkalinity. Membrane may also affect service rating.
Requirements:
- Minimum grout joint width—1/16."
- Above-ground installations are inherently more susceptible to vibration and deflection. Grout and mortar manufacturers to warrant product suitability.
- Mortar bed thickness—screed fill channels of SRSB boards flush to top of ribs and allow to cure 24 hours.
- The ends of SRSB must be fully supported. Cantilevering is not permitted.

Preparation by Other Trades:
- For decks with 8 foot and longer joists, cross bracing may be needed between joists to prevent racking. Consult SRSB manufacturer.
- Floor systems 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. Maximum allowable substrate deflection under live load not to exceed \( \frac{l}{360} \). See also Substrate Requirements.
- When concentrated loads (scissor lifts, pallet jacks, automobiles, forklifts, etc.) will be used on an above-ground tiled floor, the engineer and/or specifier shall specify a substrate to accommodate the concentrated loads. Owner/specifier is responsible for protecting the tilework from damage, including allowing sufficient time for installed materials to cure properly.
- Maximum allowable variation in the joist system—\( \frac{3}{8} \)" in 10'-0" and 1/16" in 1'-0" from the required plane.
- Slope joist system min. \( \frac{3}{8} \)" per foot. Flat deck with poor or no drainage will not perform well.

Materials:
- Multiple options exist for membranes, mortars, grouts, and other materials and MUST BE CLEARLY SPECIFIED to be included. If not specifically indicated, optional materials are not included and grout/mortar choice defaults to minimum performance specification indicated. Consider each system component and intended use to determine minimum requirements and to specify options.
- Natural stone tile—see Natural Stone Tile Selection and Installation Guide, and consult supplier for application suitability.
- Cementitious grout—ANSI A118.7 or better or ISO CG2 or better. Consider unsanded grout for soft or semisoft stones such as limestone, travertine, marble, onyx, or similar.
- Cementitious bond coat:
  - Must be recommended by manufacturer for above ground use.
  - When a membrane is not used—ANSI A118.15 or better or ISO C2S1 or better.
  - When a waterproof membrane is used—ANSI A118.15 or better or ISO C2S1 or better unless ANSI A118.1 or ISO C1 is recommended by membrane manufacturer.
  - Use white for light-colored marble, limestone, and other stones where staining or darkening from grey setting materials is possible.
- Waterproof membrane, when used—ANSI A118.10
- Waterproof membrane flashing, when used—per applicable building codes
- Mortar bed—ANSI A108.1A
- Structural ribbed self-supporting boards—recommended by manufacturer for intended use or application and meeting the following requirements:
  - Structural ribbed self-supporting boards—recommended by manufacturer for intended use or application and meeting the following requirements:
    - water absorption < 3% when tested per ASTM D570
    - passes 300 cycles when tested per ASTM C67, Section 9
    - flexural strength ≥ 2,600 psf when tested per ASTM D790
    - direct screw withdrawal resistance (using SRSB manufacturer’s recommended fastener) ≥ 250 psf when tested per ASTM D1037, Section 16
    - passes Robinson Floor Test (ASTM C627) cycles 1-10 when tested with standard 12"x12" ANSI A137.1 pressed floor tile, ANSI A118.6 grout, and ANSI A118.4 mortar; and joists spaced 16" o.c.
    - passes Robinson Floor Test (ASTM C627) cycles 1-10 when tested with standard
12"x12" ANSI A137.1 pressed floor tile, ANSI A118.6 grout, and ANSI A118.4 mortar; joists spaced 16" o.c.; and modified to accommodate a 14’ suspended floor assembly

- Receives flame spread and smoke development indices of 0-0-0-0 when exposed to fire, when tested per ASTM E84.
- Fasteners—1-5/8" pan head screws, non-corrosive and non-oxidizing.

Materials for Green/Sustainable Design
- See Green Building Standards and Green Product Selection Guide and consult manufacturers and suppliers for product sustainability and contribution to green building design.
- Consider specifying tile and installation materials that meet ANSI A138.1, the American National Standard Specifications for Sustainable Ceramic Tiles, Glass Tiles, and Tile Installation Materials.

Movement Joint (architect must specify type of joint and show location and details on drawing):
- Movement joints—mandatory according to EJ171. For above-ground installations additional movement joints are required.
- Do not extend movement joints through SRSB boards.

Installation Specifications:
- Tile—ANSI A108.5
- Cementitious grout—ANSI A108.10.
- Mortar bed—ANSI A108.1B
- SRSB—manufacturer’s directions
- Movement Joints—EJ171 and ASTM C1193.

Notes:
- State and local building codes for exterior deck construction, membrane requirements, and membrane flashing requirements vary; check applicable codes for requirements.
- Not all bonding mortars are suitable for exterior use.
- Not all mortars, grouts, and membranes are suitable for above-ground use. Check manufacturer recommendations.

- Protection of installation may be required to prevent premature exposure of setting materials to moisture.
- Some substrate materials used in wet areas are subject to deterioration from moisture. See ANSI A108.01-2.4.
- Flush cove base shown, see Using the TCNA Handbook for Specification Writing for additional base options.
- When unsanded grout is used, grout joint width must be 1/8” (nominal) or less.
Opening application presentation with SRSB.

Outdoor living is a major industry and tiling decks or a balcony on apartment buildings offers real benefits for safety from grills, fire pits, objects falling through slatted floors, it also offers dry areas under decks, and other floors of apartment buildings.

Eliminating the wood substrate element with a structural non-wood material has been achieved but a standard needs to be established as it is the foundation of the floor surface. As SRSB is the critical element in establishing a tiled floor externally, it has excellent properties to be used as the base for a tiled bathroom floor or other wet areas where wood base will expand or rot due to water penetration. A completed tiled floor measures ¾” high allowing for design elements within the home with other flooring materials. Architects would use this design element to make homes safer.

A Structural Ribbed Self-Supporting Board (SRSB) consists as a composite. This composite is made up of mixture of random and oriented glass fibers bound together with a thermosetting polymer. This composite exhibits very little creep and good strength at ambient temperatures.

This composite SRSB are pultruded boards or planks and attached directly to the wood joists in lieu of any plywood or wood decking. As such, they are a structural material.

At a minimum, SRSBs must meet the following criteria, and be meeting the requirements for use as a porcelain tile substrate: water absorption < 3% when tested per ASTM D570; Passes ASTM C67 test for freeze-thaw resistance (modified to include SRSB waterproofed assembly with tile) for 300 cycles under ASTM C67 section 8.

Flexural strength ≥ 2,600 pounds square foot tested per ASTM D790 (mortar-filled test specimen 16” long and 12” wide);

Direct screw withdrawal resistance ≥ 250 pounds/square foot when tested per ASTM D1037 section 16 with SRSB, using SRSB manufacturer’s recommended fastener.

Pass cycles 1-10 when tested per ASTM C627 (Robinson Floor test) using standard tile, grout, and mortar (see Floor Tiling Installation guide) on joist’s spaced 16” o.c., Achieve light commercial rating on 14’ 2” long 4ft wide, suspended floor ASTM C627 Robinson Floor test.

Pass ASTM E84-07 to test the burning characteristics of the material, specifically the flame spread and smoke developed indices when exposed to fire. This standard would allow for quality control at the point of manufacture with ash tests as a post manufacture standard to determine the correct usage of materials.

The SRSB standard has been in use for nine years, The SRSB as a structural product has no known failures with over 1,000,000 sq. ft. in use.
Part 1. General

1.01 Description
TI-ProBoard™ is a Structural Ribbed Self-Supporting Board (SRSB) underlayment that can be used as a single underlayment for setting tile. A pultruded fiberglass and composite product with tongue and groove along each edge. Board size is 8' or 12' long x 1' wide.

1.02 Work Included
A. This specification covers in full the installation of TI-ProBoard with joists 16” o/c.

1.03 Quality Assurance
A. FinPan guarantees the TI-ProBoard will perform as described in this manual.

B. Compatibility
01. TI-ProBoard is not to be used in conjunction with any other wood material, such as plywood or decking boards, as an underlayment. Remove any wood down to the joists.
02. FinPan is not responsible for any design load calculations. Please contact your design professional to see if your existing deck can handle the loads. TI-ProBoard weighs 1.3 lbs/ sq.ft. Fully installed approx. 11-12 lbs/ sq.ft.
1.04 Storage and handling
A. TI-ProBoard needs to be shielded from sunlight when stored outdoors for long periods (excess of 2 months). Cover with tarp to prevent damage from UV.
B. TI-ProBoard should be handled with care so as to not damage the tongues and grooves that hold the planks together.
C. Care should be taken during the cutting of TI-ProBoard due to the dust or small amounts of glass fibers that can become airborne. A wet saw is highly recommended.

1.05 Design Considerations
The structural capabilities of TI-ProBoard are well within the requirements for a normal deck. Structural considerations for the deck framing used under hot tubs are subject to design by other local codes and structural engineers for the deck frames. The design of the joists should be angled to allow a slope of 1/4” per running foot away from the structure.

1.06 Testing
A. In 2005 Robinson Floor Test ASTM C627 Using 12” x 12” porcelain tile rated “Extra Heavy” TCNA
B. In 2007 Robinson Floor test ASTM C627 using 12” x 12” porcelain tiles rated “Extra Heavy” TCNA
C. In 2009 Robinson Floor test ASTM C627 using 12” x 12” tiles rated “Heavy” by Laticrete INC
D. In 2012 Robinson 14” Suspended floor test ASTM C627 rated “Commercial” TTMAC
E. In 2008 UL E84 – 07: Surface burning Characteristics of TI-ProBoard:
   01. Calculated Flame Spread 0
   02. Flame Spread Index 0
   03. Calculated Smoke Developed 0
   04. Smoke Developed Index 0
F. ASTM C1026: Freeze/thaw 20 samples passed without any deformation
G. ASTM C67-08: 300 Cycle freeze/thaw passed without any changes or deformation.
H. ASTM 790: Flexural test ultimate load with mortar 2,600lbs/sq. ft.

1.07 Maintenance
A. Maintenance to an installed board is neither necessary nor practical.

1.08 Warranty
A. TI-ProBoard has a 10-year warranty against defects.

Part 2. Products
2.01 Materials
A. TI-ProBoard
01. TI-ProBoard is manufactured by pultrusion. Made of fiber-reinforced, composite polymers with an integral fiberglass backing. The panels are 8’x1’x3/8” or 12’x1’x3/8”.
B. Fasteners
01. Use 1-5/8” length with 1/2” Pancake Head screws that are coated to prevent corrosion.
C. Mortar
01. ANSI A108.1B
D. Membrane
01. ANSI A108.13.2.1
E. Thin set
01. ANSI 118.4 or better.
F. Tile
01. ANSI A108.5 Porcelain Tile or tile suitable for the climate zone.
02. For exterior decks the coefficient of friction for the finished surface should be rated at 0.6 or above. (new TCNA 0.43)
G. Grout
01. ANSI A108.6 or better.

Part 3. Execution
3.01 Preparation
A. Make sure that the deck frame is in good condition, sloped away from the structure and with joists 16” o/c.

3.02 Installation requirements on decks and balconies not over living area.
A. The maximum variation in the joist system is 1/4” in 10’ & 1/16” in 1’. from required plane.
B. The maximum joist span allowed is 16” o/c.
C. Width of joist span should be considered with workloads.
D. Expansion joints are mandatory with method EJ171, page 178 of the TCNA handbook. DO NOT cut the TI-ProBoard to achieve this.

3.03 Installation on existing decks
A. Prepare for tiling the deck by removing old deck boards.
B. Check the joists and support posts to make sure that they are suitable to receive the new floor.
C. Slope the joists to the required angle to allow for water run off.

01. One method is to sister a length of 2x6 lumber to each existing joist. Place TI-ProBoard on the ‘new’ joists

3.04 Installation Instructions
A. TI-ProBoard should be placed perpendicular to the joists. The first board can be placed at either edge. It is advisable that the first board be straight and square. Use a square and chalk line for the accuracy of the first board. The grooved edge should face the outside of the deck to allow the next board to be pressed into the tongue.
B. Screw TI-ProBoard to the joist using 1-5/8” screw with 1/2” Pancake Head with corrosion protection. (For screw position on each board please see Figure 1 on page three.)
C. When joining 2 boards, butt each board equally over a joist and screw each board. Do not maintain a continual seam. All seams should be staggered and no board should be shorter than the span of three joists.
D. For cutting TI-ProBoard, a wet saw is highly recommended, although cutting the board can be achieved by using a circular saw with a dust mask.

E. All joints, when the deck is completed, should be checked to see that the tongue and grooved boards are all firmly in place and flush.

![Figure 1. Screw Pattern For TI-ProBoard](image)
(The black dots show the screw position of the 2 boards clipped together)

3.05 End support

A. Do not leave an end of TI-ProBoard unsupported. Wherever this occurs, blocking must be added to the joists to support the ends of the TI-ProBoard.

3.06 Preparation For Tiling On TI-ProBoard

A. Fill the channels between the ribs with a medium bed mortar. Screed the mortar level with the top of the ribs and let dry before moving to the next stage. Normally after 24 hours the next step can start. Follow the mortar manufacturer’s recommendations.

B. When it comes to waterproofing please follow the membrane manufacturer’s recommendations.

3.07 Protective/Decorative Edging.

A. Protective and decorative edging should be used around the perimeter of the deck/balcony, etc. This can be done after the TI-ProBoard has been screwed down and mortar bed applied.

  01. Press TI-Edging into the thin set with the long side pressed against the vertical board. Leave a 1/4” gap between the tile and TI-Edging.

  02. Caulk the 1/4” gap prior to grouting with a caulk/grout that matches the grout color.

3.08 Setting the Tile.

A. Latex modified thin set, meeting or exceeding ANSI standard 118.4 is required for tiling outdoors. Tile should have a minimum of 98% coverage of thin set; apply to both the back of the tile and deck bed to ensure 98% coverage is achieved.

B. Notch trowel sizes

  01. For 12” and 13” tiles use a 1/4”x3/8”x1/4” notched trowel.

  02. For 16” and 18” tile use a 3/8”x3/8”x3/8” notched trowel.

C. For exterior decks, use a fully vitrified or porcelain tile, this may vary in certain regions depending on freeze/thaw variances. The coefficient of friction for the finished surface should be rated at 0.6 or greater. (new rule .43)

D. Only grouts, either sanded or epoxy, with an exterior rating can be used.

3.09 Installation of tile around guard rail wood posts.

A. If tiling around a railing post that is prone to expansion and contraction, allow a 1/2” gap around the post or each side if a square post is used.

B. Cover the bottom of the post with decorative molding.
Bibliography of the documents for the submission of SRSB board into the TCNA Handbook

**BM Page1, Page 2, Page 3 - (2011)** - These documents cover the thermal cycling tests completed by Bowser Morner with low temp of -40°. The first page is the written lab report, and the 2nd and 3rd pages are the supporting graphs for the report.

**Bowser Morner - (2004)** - These were a series of thermal cycling tests conducted with a low temp of -30° by Bowser Morner.

**Final Report_Tile Diy_UL - (2008)** - This is a surface burning characteristics test completed by UL laboratories. The results showed 0-0-0-0-0. For flames, smoke, etc.

**Freeze thaw0001 - (2006)** - This lab report, compiled by the Tile Council of North America’s product services division, shows the results of a series of Freeze-thaw test based on ASTM C1026.

- A further test with 300 cycles was performed by Roy Gorton Ironrock

**GFRP panel test report, Report #1 - (2010)** - This report was conducted by the University of Kentucky’s Department of Civil Engineering. There are 2 tests located within the report. The first tested the flexural strength of the boards, and the second tested the pull out strength of the boards and their fasteners.

**GFRP panel test report, Report #2 - (2010)** - This report was conducted by the University of Kentucky’s Department of Civil Engineering. This test copied the procedures used in ASTM D790 to test flexural capacity of the boards.
Bibliography of the documents for the submission of SRSB board into the TCNA Handbook

*Installation Instructions*- (2010) – Details the installation methods used for the boards.

*MSDS*- (2016) – This document covers the material make up of the boards and any safety requirements needed for the material.

*RLS2271r*- (2008) -This is a Robinson Floor Test conducted by Laticrete International, Inc.’s Department of Product Management.


*SRSB letter from Brian Turner*- (2010) – This is a letter to the Tile Council of North America detailing why the SRSB boards should be included into the TCNA Handbook.

*TCNA deflection* - (2006) – This report details the results of a ASTM C627 “Robinson Floor test” conducted by the Tile Council of North America.

*Therm Ex*- (2007) - This test was conducted to represent the procedures found in ASTM- 696-78 for thermal expansion. The test was conducted by Vern Kallenborn.
LABORATORY REPORT

NATTCO
1452 Donaldson Hwy
Erlanger, KY 41018

Attention: Seth Wentz

Thermal Cycling Tests

SAMPLE DESCRIPTION:
The client submitted three (3) tiles applied to sub-flooring material.

TEST METHODS:
The samples were placed in a temperature chamber. The chamber was programmed to cycle the temperature between 120°F and -40°F. The cycle as follows:

<table>
<thead>
<tr>
<th>Time</th>
<th>Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 hrs</td>
<td>go to 120°F</td>
</tr>
<tr>
<td>2 hrs</td>
<td>at 120°F</td>
</tr>
<tr>
<td>2 hrs</td>
<td>go to -40°F</td>
</tr>
<tr>
<td>2 hrs</td>
<td>at -40°F</td>
</tr>
</tbody>
</table>

The above cycle was repeated a total of 3 times for a total exposure period of 24 hours. The cycle was repeated again due to the chamber controller not performing the temperature profile correctly. Temperature profile graphs are included in this report.

TEST RESULTS:
No deformation or physical damage was observed as a result of being subjected to 48 hours of temperature cycling.

Respectfully Submitted,
BOWSER-MORNER, INC.

Bud Miyahara
Test Engineer
Product Testing Laboratory

All Reports Remain The Confidential Property Of BOWSER-MORNER And No Publication Or Distribution Of Reports May Be Made Without Our Express Written Consent, Except As Authorized By Contract. Results Contained in this Report are Reflective Only of The Items Calibrated or Tested. All samples recovered from this project will be retained for 30 days before disposal, pending disposition notification from the client.
Correct soak time at -40 degrees.

No soak time at -40 degrees.
LABORATORY REPORT

TO: NATTCO
7960 Kentucky Drive, Suite 10-11
PO Box 0845
Florence, KY 41042

Attention: Vern Kallenborn

BMI NO: 10014349
GROUP NO: 47324
SAMPLE NO: 410449
P. O. NO: BM10134
DATE: October 14, 2004

ON: Thermal Cycling Tests

SAMPLE DESCRIPTION:
The client submitted seven (7) deck underlay samples identified as D, E, F, G, H, I, & J.

TEST METHODS:
The samples were placed in a temperature chamber. The chamber was programmed to cycle the temperature between 130°F and -30°F. The cycle as follows:

<table>
<thead>
<tr>
<th>Time</th>
<th>Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 hrs</td>
<td>go to 130°F</td>
</tr>
<tr>
<td>2 hrs</td>
<td>at 13°F</td>
</tr>
<tr>
<td>2 hrs</td>
<td>go to -30°F</td>
</tr>
<tr>
<td>2 hrs</td>
<td>at -30°F</td>
</tr>
</tbody>
</table>

The above cycle was repeated a total of 3 times for a total exposure period of 24 hours.

TEST RESULTS:
No deformation or physical damage was observed as a result of being subjected to 24 hours of temperature cycling.

Respectfully Submitted,
BOWSER-MORNER, INC.

Robert J. Rosencrans
Senior Test Engineer
Product Testing Laboratory

All Reports Remain The Confidential Property Of BOWSER-MORNER And No Publication Or Distribution Of Reports May Be Made Without Our Express Written Consent, Except As Authorized By Contract. Results Contained in this Report are Reflective Only of The Items Calibrated or Tested. All sample recovered from this project will be retained for 30 days before disposal, pending disposition notification from the client.
April 11, 2008

Mr. Seth Wentz
Tile-diy LLC
1965 International Way
Hebron, KY 41048
United States

Our Reference: SV17262/08CA11093

Subject: Report Of Surface Burning Characteristics Tests On Samples As Submitted By Tile-diy LLC

Dear Mr. Wentz:

This is a Report summarizing the results of a test conducted under the Commercial Inspection and Testing Services (CITS) program identified as Assignment No. 08CA11093.

GENERAL:

The results relate only to items tested.

METHOD:

The test was conducted in accordance with Standard ANSI/UL723, ninth edition; dated August 29, 2003, "Test for Surface Burning Characteristics of Building Materials" (ASTM E84-07).

The test determines the Surface Burning Characteristics of the material, specifically the flame spread and smoke developed indices when exposed to fire.

The maximum distance the flame travels along the length of the sample from the end of the igniting flame is determined by observation. The Flame Spread Index of the material is derived by plotting the progression of the flame front on a time-distance basis, ignoring any flame front recession, and using the equations described below:

A. \[ CFS = 0.515 \, A_T \] when \( A_T \) is less than or equal to 97.5 minute-foot.

B. \[ CFS = \frac{4900}{(195-A_T)} \] when \( A_T \) is greater than 97.5 minute-foot.

Where \( A_T = \) total area under the time distance curve expressed in minute-foot.
The Smoke Developed Index (SDI) is determined by rounding the Calculated Smoke Developed (CSD) as described in UL 723. The CSD is determined by the output of photoelectric equipment operating across the furnace flue pipe. A curve is developed by plotting the values of light absorption (decrease in cell output) against time. The CSD is derived by expressing the net area under the curve for the material tested as a percentage of the area under the curve for untreated red oak.

The CSD is expressed as:

\[ \text{CSD} = \left( \frac{A_m}{A_{ro}} \right) \times 100 \]

Where:

- \( \text{CSD} = \) Calculated Smoke Developed
- \( A_m = \) the area under the curve for the test material.
- \( A_{ro} = \) the area under the curve for untreated red oak.

SAMPLES:

The samples utilized in this investigation were neither prepared nor selected by a Laboratories’ representative such that no verification of composition can be provided.

**Table 1: Sample Description**

<table>
<thead>
<tr>
<th>Test No.</th>
<th>System</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>PROBOARD SAMPLES (Flooring Material)</td>
</tr>
</tbody>
</table>

Due to the rigidity of the test samples, supplementary means of support was not required.

RESULTS:

The results are tabulated below are considered applicable only to the specific samples tested.

Data sheets and graphical plots of flame travel versus time and smoke developed versus time are also enclosed.
### Table 2: Test Summary

<table>
<thead>
<tr>
<th>Test No.</th>
<th>Test Code</th>
<th>Sample Description</th>
<th>CFS Calculated Flame Spread</th>
<th>FSI Flame Spread Index</th>
<th>CSD Calculated Smoke Developed</th>
<th>SDI Smoke Developed Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>04090807</td>
<td>PROBOARD SAMPLES (Flooring Material)</td>
<td>0</td>
<td>0</td>
<td>0.0</td>
<td>0</td>
</tr>
</tbody>
</table>
The Classification Marking of Underwriters Laboratories Inc. on the product is the only method provided by Underwriters Laboratories Inc. to identify products, which have been produced under its Classification and Follow-Up Service. No use of a Classification Marking has been authorized as a result of this investigation.

Since the anticipated work has been completed, we have instructed our Accounting Department to terminate the investigation and invoice you for the charges incurred to date.

Should you have any questions, please contact the undersigned.

Very truly yours

Reviewed by:

Jamila Shawon (ext. 42607)  James Smith (ext. 42666)
Engineer Project  Staff Engineering Associate
Fire Protection Division  Fire Protection Division
Underwriters Laboratories Inc.

Project: 08CA11093    File: SV17262    Test Code: 04090807
Tested by: KNIGHTON    Engineer: SHAWON    Date: 04/09/08
Employee #: 1291    Emp. #: 15488

TEST METHOD: The test was conducted in accordance with UL 723, 9th Edition

<table>
<thead>
<tr>
<th>Client Name:</th>
<th>Tile-di-y L L C</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Test Duration</th>
<th>10 Minutes</th>
<th>Test No.:</th>
<th>1</th>
<th>Hot Test:</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mounting:</td>
<td>Self</td>
<td>Test Type:</td>
<td>Developmental</td>
<td>Burn-Out Required:</td>
<td>No</td>
</tr>
</tbody>
</table>

**Test Sample:** PROBOARD SAMPLES (Flooring Material)

**FLAME SPREAD RESULTS**

- No Ceiling Ignition
- **Calculated Flame Spread (CFS):** 0
- **Flame Spread Index (FSI):** 0
- **Time to Ignition (sec):** 0
- **Maximum Flame Spread (ft):** 0
- **Area Under the Flame Spread Curve (ft.-min):** 0

**SMOKE RESULTS**

- **Calculated Smoke Developed (CSD):** 0.0
- **Smoke Developed Index (SDI):** 0
- **Area Under the Smoke Curve (sq. in.):** 0.00
- **Area Under Red Oak Curve (sq. in.):** 86.82
Flame Spread / Smoke Results

Tile-diy LLC
PROBOARD SAMPLES (Flooring Material)

Test No. 1
08CA11093 / SV17262
04090807

Flame Spread Index: 0
Smoke Developed Index: 0
Max. Flame Spread: 0
TEST REQUESTED BY: North American Tile & Tool Co.
   Attn: Brian Turner
   1965 International Way
   Hebron, KY 41048

TEST SUBJECT MATERIAL: Identified by client as: T.I. Proboard 3/8 B500

TEST DATE: 9/25/06-10/16/06

   -Ten specimens were tested.
   -The specimens were subjected to fifteen cycles of freeze-thaw consisting of freezing the tiles at 0°F for eight hours then thawing the tiles in water at 74°F.

TEST RESULTS: All ten (10) specimens showed no visible evidence of freeze-thaw damage after completing fifteen (15) cycles of freeze-thaw. *

* Note: “Upon examination of the test units upon completion of the prescribed 15 cycles of freezing and thawing, the complete test units were intact. There was no observable separation of the thin-set layer from the backing material. Additionally, no spalling due to thermal cycling was noted for either the back layer or the face layer.”

Virgil Irick
Director of Laboratory Services
10/22/06

This report is confidential and has been prepared for the exclusive use of the client. It is not an endorsement, approval, certification, or criticism of any product by TCNA. This report shall not be published in any form without prior written consent of TCNA.
TEST REQUESTED BY: North American Tile & Tool Co.
Attn: Brian Turner
1965 International Way
Hebron, KY 41048

TEST SUBJECT MATERIAL: Identified by client as: T.I. Proboard 3/8 B600

TEST DATE: 9/25/06-10/16/06

-Ten specimens were tested.
-The specimens were subjected to fifteen cycles of freeze-thaw consisting of freezing the tiles at 0°F for eight hours then thawing the tiles in water at 74°F.

TEST RESULTS: All ten (10) specimens showed no visible evidence of freeze-thaw damage after completing fifteen (15) cycles of freeze-thaw.

* Note: “Upon examination of the test units upon completion of the prescribed 15 cycles of freezing and thawing, the complete test units were intact. There was no observable separation of the thin-set layer from the backing material. Additionally, no spalling due to thermal cycling was noted for either the back layer or the face layer.”

Virgil Irick
Director of Laboratory Services

10/23/06

Submitted to:
Brian Turner
North American Tile Tool Company
1452 Donaldson Hwy
Erlanger, KY 41048
Tel: (859) 525-8891
Fax: (859) 525-8899
Email :Brianturner@nattco.com

Vern Kallenborn
North American Tile Tool Company
1452 Donaldson Hwy
Erlanger, KY 41048
Tel: (859) 525-8891
Fax: (859) 525-8899
Email :v.kallenborn@insightbb.com

Date of Testing: June 07, 2010
Testing Conducted by: Mr. Abheetha Peiris (Ph.D. Student)
Mr. Drew Thompson (MS Student)

Date of Report: June 14, 2010 (Draft)
Report Prepared by: Abheetha Peiris and Drew Thompson
Tel: (859) 257-8010
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E-mail: abheetha@engr.uky.edu, dcthom3@uky.edu

Report Reviewed by: Dr. Issam Harik

Contact: Dr. Issam E. Harik
University of Kentucky
Department of Civil Engineering
176 Raymond Building
Lexington, KY 40506-0281
Tel: (859) 257-3116
Fax: (859) 257-1815
E-mail: iharik@engr.uky.edu
SUMMARY

This report presents the results of two tests carried out on TI-PROBOARD™ panels.

**Test Series #1:** In Series #1, three TI-PROBOARD™ composite panels Type AFP/09, with screed mortar, are tested to determine their flexural capacities. The panels were subjected to a line load at mid span and the ultimate load at failure was recorded for each of the specimens (Figure 1). The test results are presented in Table 1.

**Table 1:** Results for Test Series #1 – Flexural Capacity of TI-PROBOARD™ Composite Panels Type AFP/09 with Screed Mortar

<table>
<thead>
<tr>
<th>Specimen Number</th>
<th>Span</th>
<th>Width</th>
<th>Thickness</th>
<th>Load at Failure</th>
<th>Deflection at Failure</th>
<th>Type of Failure</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>16</td>
<td>12</td>
<td>0.375</td>
<td>2,633</td>
<td>1.79</td>
<td>All three specimens failed when the laminate in the panel split underneath and along the length of the ribs along the outside edges.</td>
</tr>
<tr>
<td>2</td>
<td>16</td>
<td>12</td>
<td>0.375</td>
<td>2,553</td>
<td>1.75</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>16</td>
<td>12</td>
<td>0.375</td>
<td>2,604</td>
<td>1.83</td>
<td></td>
</tr>
<tr>
<td><strong>Average</strong></td>
<td></td>
<td></td>
<td></td>
<td><strong>2,597</strong></td>
<td><strong>1.79</strong></td>
<td></td>
</tr>
</tbody>
</table>

1 The line load was applied using a 12” long steel bar.

**Test Series #2:** In Series #2, a single TI-PROBOARD™ composite panel Type AFP/09, with screed mortar, is tested to determine the pull-out strength of the panels from the screws. The panel was subjected to a uniformly distributed load and the load at which the panel came off the screws was recorded (Figure 6). The test results are presented in Table 2.

**Table 2:** Results for Test Series #2 – Pull-out capacity of TI-PROBOARD™ Composite Panels Type: AFP/09 with Screed Mortar

<table>
<thead>
<tr>
<th>Specimen Identification</th>
<th>Span</th>
<th>Width</th>
<th>Thickness</th>
<th>Failure Load</th>
<th>Maximum Deflection</th>
<th>Type of Failure</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>16</td>
<td>12</td>
<td>0.375</td>
<td>259³</td>
<td>0.09³</td>
<td>Specimen failed when panel split at screws and separated from the support.</td>
</tr>
</tbody>
</table>

2 The load was applied using a 12”×12” steel plate
3 The weight of the steel loading plate and spacer plates has been added to the applied load
4 The deflection due to the loading plate and spacer plates are not included
DETAILS

Test 1: Composite Panel (Type: AFP/09) Flexural Test

The testing of the TI-PROBOARD™ panels (Type: AFP/09) was conducted in a manner similar to the ASTM D790 test, but with several modifications to accommodate the specimen size and actual field support conditions.

1. Three test specimens were provided by North American Tile Tool Company. All panels were prepared for flexural testing to determine the ultimate load at failure.

2. The panels spanned 16” from outside to outside of the 2” × 6” timber supports, and each panel was 12” wide with an average thickness of 0.375”. The panels included dove-tailed ribs spaced 1 ½” apart and had screed mortar placed between the ribs.

3. The panels were fastened to the supports by 1 ¼” length screws. Two screws were applied on each side with one near mid-span and the other next to the rib at the edge where the connection to the adjoining rib was placed [Fig. 1 (a)].

4. A 12” × 16” plywood piece was attached to the bottom of the supports to prevent the supports from moving during the loading. A line load was applied on the specimens using a 12” long steel bar as seen in Figure 1.

5. The loading rate was set at 0.1”/min. Failure was defined as the point where a sudden drop in the load carrying capacity was observed at which point the test was terminated.

6. All three specimens failed suddenly with a splitting noise at an average failure load of 2,597 lbs/ft (Table 1). The load deformation plots for all three specimens are given in Figure 2.

7. Splitting of the panels was observed, on all three specimens, underneath the ribs near the edges as shown in Figure 3.

8. The panels also had local splitting at screw locations (Fig. 4), but in all cases the panel was yet to break away from the screw when failure occurred under the ribs.

9. Cracking and spalling of concrete was observed on the surface (Fig. 5) especially between the ribs closer to the edges on all three specimens.
Figure 1: TI-PROBOARD™ panels (Type: AFP/09) Specimen for Flexural tests
Figure 2: Load-Deflection relation for all specimens

Figure 3: Splitting of panel under ribs next to edge in specimen 1 and 2
Figure 4: Local splitting of panel near screw locations in specimens 2 and 3

Figure 5: Concrete cracks and spalling on top surface of specimen 2
Test 2: Composite Panel (Type: AFP/09) Pull-out Test

The testing of the TI-PROBOARD™ panel (Type: AFP/09) for pull-out from the screws was performed by applying a uniform load to the underside of the panel.

1. The test specimen was provided by North American Tile Tool Company. The panel was prepared for pull-out testing to determine the load at which the panel would come free of the screws.

2. The panels spanned 16” from outside to outside of the 2”×6” timber supports, and each panel was 12” wide with an average thickness of 0.375”. The panels included dove-tailed ribs spaced 1 ½” apart and had screed mortar placed between the ribs.

3. The panels were fastened to the supports by 1 ¼” length screws. Two screws were applied on each side with one near mid-span and the other next to the rib at the edge where the connection to the adjoining rib was placed [Fig. 1 (a)].

4. Additional 2”×6” timber supports were attached to the existing 2”×6” timber supports as seen in Figure 6 to set the panel upside down in order for load application. The supports were connected to each other to prevent them from moving during loading.

5. 1” thick 12”×12” steel plate was placed on the underside of the panel in order distribute the applied load as a uniform load as seen in Figure 6 (b). The weight of the loading plate as well as the spacer plates used was 117 lbs.

6. The loading rate was set at 0.1”/min. Failure was defined as the point where sudden a drop in the load carrying capacity was observed.

7. At an applied load of 142 lbf a sharp drop in load carrying capacity was observed as seen in Figure 7. This is believed to be when the panel splits away from the screws at mid span as seen in Figure 8. The load is seen to pick up after the initial drop as the panel cantilevers from the screws at the edge.

8. The weight of the steel plates used as the loading plate and as the spacer pates have been added to the applied load and reported as the ultimate pull-out load of 259 lbs/ft² (Table 2). The deflections due to the steel plates were not measured and are neglected.
Figure 6: TI-PROBOARD™ panel (Type: AFP/09) Specimen for Pull-out test
Figure 7: Load-Deflection relation AFP/09 type pull-out specimen

Figure 8: Local splitting of panel at screw at mid-span

Submitted to:

Brian Turner
North American Tile Tool Company
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Erlanger, KY 41048
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Fax: (859) 525-8899
Email :v.kallenborn@insightbb.com

Date of Testing: June 07, 2010

Testing Conducted by: Mr. Abheetha Peiris (Ph.D. Student)
Mr. Drew Thompson (MS Student)

Date of Report: June 14, 2010 (Draft)

Report Prepared by: Abheetha Peiris and Drew Thompson
Tel: (859) 257-8010
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E-mail: abheetha@engr.uky.edu, dcthom3@uky.edu

Report Reviewed by: Dr. Issam Harik

Contact: Dr. Issam E. Harik
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176 Raymond Building
Lexington, KY 40506-0281
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Fax: (859) 257-1815
E-mail: iharik@engr.uky.edu
SUMMARY

This report presents the results of a test carried out on TI-PROBOARD type Doyle/06 panels. A single panel of type Doyle/06 (without screed mortar), is tested to determine its flexural capacity. The panel was subjected to a line load at mid span and the ultimate load at failure was recorded (Figure 1). The test results are presented in Table 1.

Table 1: Flexural Capacity of a Single TI-PROBOARD™ Panel Type Doyle/06 (without Screed Mortar)

<table>
<thead>
<tr>
<th>Specimen Number</th>
<th>Span</th>
<th>Width</th>
<th>Thickness</th>
<th>Load at Failure¹</th>
<th>Deflection at Failure</th>
<th>Type of Failure</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>16</td>
<td>6</td>
<td>0.375</td>
<td>605</td>
<td>1.88</td>
<td>Specimen failed by rupture in the laminate along the centerline under the line load (or steel bar in Figure 1)</td>
</tr>
</tbody>
</table>

¹A line load was applied using a 12” long steel bar. The value reported is the total force applied.
DETAILS

Test 1: Non-composite Panel (Type: Doyle/06) Flexural Test

The testing of the Non-composite TI-PROBOARD™ panel (Type: Doyle/06) was conducted in a manner similar to the ASTM D790 test, but with several modifications to accommodate the specimen size and actual field support conditions.

1. The test specimen was provided by North American Tile Tool Company. The panel was prepared for flexural testing to determine the ultimate load at failure.
2. The panel spanned 16” from outside to outside of the 2”×6” timber supports, and was 6” wide with an average thickness of 0.375”. The panel had dove-tailed ribs spaced 1 ½” apart but did not have screed mortar between the ribs.
3. The Doyle/06 type panel was fixed to the wooden supports by 1” deep staples with two staples on either side.
4. A 16”×12” plywood piece was attached to the bottom of the supports to prevent the supports from moving during loading. A line load was applied on the specimens using a 12” long steel bar as seen in Figure 1.
5. The loading rate was set at 0.1”/min. Failure was defined as the point where a sudden drop in the load carrying capacity was observed at which point the test was terminated.
6. The specimen failed suddenly in rupture at a failure load of 605 lbs (Table 1). The load deformation plot for the specimen is given in Figure 2.
7. The rupture lines were directly below the line load as seen in Figure 3.
Figure 1: TI-PROBOARD™ panel (Type: Doyle/06) Specimen for Flexural test
Figure 2: Load-Deflection relation Doyle/06 type specimen

Figure 3: Rupture lines at mid-span underneath line load.
Balcony Deck

Installation Instructions.

Preparation by Other Trades:

- Maximum Variation in the joist system- ¼” in 10’-0 and 1/16 in 1’-0” from the required plane.
- Slope joist system ¼” per foot for water drainage.
- The maximum joist span allowed is 16” on center. Width of joist should be considered with work loads.
- Use 1 5/8” length ½” pan head screws

Movement Joint (architect must specify type of joint and show location and details on drawing):

- Movement joints- mandatory in accordance with method EJ171, page 78. For above Ground installations additional movement joints are required. Do not make cuts for movement joints through the SRSB boards.

Installation Specifications:

- Mortar- ANSI A108.1B
- Membrane – ANSI A108.13 & A 118.10
- Tile- ANSI A108.5
- Grout ANSI A108.10 / ANSI A118.6 or ISO CG1 or better

1) Make sure the structure has the proper slope as recommended by the Tile Council of North America’s 45 Edition Handbook Section F103-07 and F104-07. The slope of the structure is important for proper water drainage away from the building. Recommended joist spacing is 16” on centers. The width of joist should be considered with work loads. SRSB should be placed perpendicular to the joists. The first board can be placed at either edge of the deck depending on which direction is more comfortable for the installer.

2) It is essential for the 1st board to be square and straight. Use a square and chalk line to insure the accuracy of the placement of the 1st board. The grooved edge of the 1st board is placed away from the center of the deck.
Balcony Deck

3) Fix SRSB to the deck joists using 1 5/8” coated deck screw behind the 1st rib on every joist. A coated screw is important to resist corrosion. Pan Head screws are recommended. Simply drive the screw through.

4) 6” behind the 1st screw on a joist a 2nd screw should be placed. Each board should have 2 screws per board on every joist. A line is indicated on the board where fastening should take place over the joist.

5) Clip your next board onto the previous board using the tongue and groove on either edge of the board. It is critical to use a rubber mallet to make sure the clips are fully sealed together to create a smooth surface to apply the tile. Not clipping the boards fully together could result in the tiles being uneven or detaching from the sub-surface.

6) A screw should be placed behind the clip at every joist to insure locking the 2 boards together. Repeat the process until the deck structure is completely covered by SRSB. The excess board can be cut off to create a flush edge.

7) Use a wet saw or circular saw with a carbide blade. Follow the saw manufacturers’ recommendations for safety precautions when cutting SRSB. If cutting SRSB parallel to the ribs, the cut should be done as close to a rib as possible.

8) When joining or butting 2 pieces of SRSB together always join or but the edges over a joist. Each joining or butting edge should share equal parts of a joist. Each edge of the SRSB should receive a screw. Do not maintain a continual seam along the same joist. Stagger all seams. A piece of SRSB should always be fixed to at least 3 joists.

9) Although, the installation of SRSB allows for the use of tile in an exterior situation, the use of expansion or movement joints is mandatory. For an explanation of the installation of expansion or movement consult the industry standards guide set by the TCNA handbook for Ceramic Tile Installation Section EJ171-07.

Installing Tile on SRSB:

Mortar

Apply mortar to SRSB making sure to fill completely between all of the ribs. Screed mortar flush with the top of the ribs. Follow manufacturer’s recommendations.

1) Waterproof Membrane –
   Please follow manufacturer’s recommendations for application of water proof membrane. Waterproof membranes are required in areas subject to freeze thaw.

2) Thin- Set
Balcony Deck

Latex modified Thin-Set meeting ANSI Standard 118.4 or above is required for tiling outdoors. Please consult the thin-set manufacturer for proper trowel notch-size.

4) Grout

Only recommended grouts should be used for exterior applications.

Tile and Finishing Materials.

Tile should only be used if recommended for exterior applications in your specific climate zone. Consult the tile manufacturer for their recommendations.

Any items added to a deck (ex. hot tub) the deck’s structure should be check by a professional before the item is installed.
1. INGREDIENTS:

- Fiber Glass Fibers
- Polymerized Polyester-Styrene Thermosetting Resin

2. PHYSICAL DATA:

- BOILING POINT: N/A
- VAP. PRESS: N/A
- VAP. DENSITY: N/A
- SOL. IN WATER: Insoluble
- SP. GRAVITY: N/A
- APPEARANCE: solid color
- ODOR: NONE

3. FIRE AND EXPLOSION HAZARD DATA:

- FLASH POINT: N/A
- METHOD USED: N/A

FLAMMABLE LIMITS
- LFL: N/A
- UFL: N/A

EXTINGUISHING MEDIA:

- Water, C02, Dry Chemical

(continued on page 2)
3. FIRE AND EXPLOSION HAZARD DATA: (CONTINUED)

FIRE AND EXPLOSION HAZARDS: Fiber glass-polyester composite profiles in common with other natural and polymeric organic materials can present unreasonable fire risks in certain misapplications when exposed ignition sources in air. Once ignited, such fires can burn rapidly and produce intense heat, dense smoke and irritating or toxic gases.

Carbon dioxide, carbon monoxide, possible traces of free elemental carbon, and nitrogen oxides evolved under fire conditions.

FIRE FIGHTING EQUIPMENT: Wear positive pressure self-contained breathing apparatus and protective turnout clothing.
4. REACTIVITY DATA:

STABILITY: Stable
INCOMPATIBILITY: None known
HAZARDOUS POLYMERIZATION: Will not occur

5. ENVIRONMENTAL AND DISPOSAL INFORMATION

ACTION TO TAKE ON SPILLS: N/A
DISPOSAL METHOD: Burial as landfill

6. HEALTH HAZARD DATA

EYE: Solid or dust may cause irritation or corneal injury due to mechanical action.
SKIN CONTACT: Mechanical injury only.
SKIN ABSORPTION: Skin absorption unlikely due to physical properties.
INGESTION: Ingestion is unlikely due to physical state.
INHALATION: Any dust from these beams may cause irritation to upper respiratory tract.
SYSTEMIC AND OTHER EFFECTS: Based on available data, repeated exposures are not anticipated to cause any significant adverse effects.

7. FIRST AID:

EYES: Irrigate immediately with water for at least 5 minutes.
SKIN: Wash any dust with flowing water.
INGESTION: No adverse effects anticipated by this route of exposure.
INHALATION: Remove to fresh air.
8. HANDLING PRECAUTIONS:

EXPOSURE GUIDELINES: Nuisance dust

VENTILATION: Local exhaust recommended when sawing, drilling or abrading indoors.

RESPIRATOR PROTECTION: Dust mask when sawing, drilling or abrading.

SKIN PROTECTION: Gloves may be required for local hand protection.

EYE PROTECTION: Use safety glasses when sawing, drilling or abrading.

9. ADDITIONAL INFORMATION
Robinson Floor Test on TI Pro Board
Project Number RLS 2271
Requested by Ken Barnum, Product Manager

Revision A
Section I – Executive Summary

Many Dal Tile distributors have started carrying a product called TI Pro Board. TI Pro Board is a plastic decking material for residential decks. It is designed to be covered with ceramic tile. Only Merkrete has a specification for tile setting materials over the TI Pro Board. The goal of this project was to develop a LATICRETE system for installing tile over TI Pro Board.

A system consisting of LATICRETE® 226 Thick Bed Mortar mixed with LATICRETE 3701 Mortar Admix as a mortar bed, LATICRETE Hydro Ban™ as a waterproofing membrane, LATICRETE 254 Platinum as the thinset adhesive, and LATICRETE SpectraLOCK® Grout was tested and qualified. The system received a “Heavy Service” rating as per Tile Council of North America performance levels using ASTM C-627 Robinson Floor Test.

This report will be forwarded to the Product Management Department so they can arrange to have a proprietary specification written.
Section II – Goal
The goal of this project was to determine the Service rating as per Tile Council of North America performance levels using ASTM C-627 Robinson Floor Test on the system of LATICRETE® 226 Thick Bed Mortar mixed with LATICRETE 3701 Mortar Admix as a mortar bed, LATICRETE Hydro Ban™ as a waterproofing membrane, LATICRETE 254 Platinum as the thinset adhesive, and LATICRETE SpectraLOCK® Grout installed on TI Pro Board.

Section III – Procedures
1. A wooden joist system consisting of 4 joists placed 16 inches on center was assembled on the Robinson Floor Tester. The joists were 2 x 4 lumber. See photo in Appendix.
2. The TI Pro Board was screwed to the joists as per the manufacturer’s directions. See the photo in Appendix.
3. The LATICRETE 226 Thick Bed Mortar mixed with LATICRETE 3701 Mortar Admix at a liquid to powder ratio of 0.1 was screeded into the TI Pro Board. See the photo in Appendix.
4. The mortar bed was allowed to cure overnight and LATICRETE Hydro Ban was installed. See the photo in Appendix.
5. 12 in. x 12 in. Dal Tile porcelain tile was installed using LATICRETE 254 Platinum at a water to powder ratio of 0.229. The grout joints were ¼ inch wide. See the photo in Appendix.
6. The grouts spacers were removed and the tile was grouted with LATICRETE SpectraLOCK® Grout. See the photo in Appendix.
7. The grout was allowed to cure 28 days. The Robinson Floor Test was run as per ASTM C-627.
Section IV – Results

<table>
<thead>
<tr>
<th>Cycle</th>
<th>Type of Wheels</th>
<th>Total Weight per Wheel</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Soft Rubber</td>
<td>100lbs</td>
<td>No damage</td>
</tr>
<tr>
<td>2</td>
<td>Soft Rubber</td>
<td>200lbs</td>
<td>No damage</td>
</tr>
<tr>
<td>3</td>
<td>Soft Rubber</td>
<td>300lbs</td>
<td>No damage</td>
</tr>
<tr>
<td>4</td>
<td>Soft Rubber</td>
<td>300lbs</td>
<td>No damage</td>
</tr>
<tr>
<td>5</td>
<td>Hard Rubber</td>
<td>100lbs</td>
<td>No damage</td>
</tr>
<tr>
<td>6</td>
<td>Hard Rubber</td>
<td>200lbs</td>
<td>No damage</td>
</tr>
<tr>
<td>7A</td>
<td>Hard Rubber</td>
<td>300lbs</td>
<td>Broken wheel - impact to tile but no noticeable damage</td>
</tr>
<tr>
<td>7B</td>
<td>Hard Rubber</td>
<td>300lbs</td>
<td>No noticeable damage</td>
</tr>
<tr>
<td>8</td>
<td>Hard Rubber</td>
<td>300lbs</td>
<td>Impact point and cracking on tile where wheel broke</td>
</tr>
<tr>
<td>9</td>
<td>Steel</td>
<td>50lbs</td>
<td>Increase cracking at impact</td>
</tr>
<tr>
<td>10</td>
<td>Steel</td>
<td>100lbs</td>
<td>No further damage</td>
</tr>
<tr>
<td>11</td>
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<td>No further damage</td>
</tr>
<tr>
<td>13</td>
<td>Steel</td>
<td>250lbs</td>
<td>No further damage</td>
</tr>
<tr>
<td>14</td>
<td>Steel</td>
<td>300lbs</td>
<td>Chipped tile at grout joint Piece of originally damaged tile missing Further opening of cracks</td>
</tr>
</tbody>
</table>

See Appendix for photo of broken wheel (7A) and chipped tile (14).
Please note, it is very unusual to have a hard rubber wheel break. I believe the wheel was defective.

Section V – Conclusions
The system received a “Heavy Service” rating as per Tile Council of North America performance levels using ASTM C-627 Robinson Floor Test.

Section VI – Actions
This report will be forwarded to the Product Management Department so they can arrange to have a proprietary specification written.
Appendix

Joist System with Ti Pro Board Installed
TI Pro Board installed overhead view
Mortar bed installed
LATICRETE Hydro Ban™ being applied
Tile installed with LATICRETE® 254 Platinum
Grout installed with LATICRETE® SpectraLOCK® Grout
Broken wheel at Cycle 7
Chipped tile at Cycle 14
Tile DIY LLC. would like to propose structural underlayment boards be added to the Tile Council of North America’s Handbook for Ceramic Tile Installation.

Structural ribbed self-supporting boards (SRSB) are a pultruded product, and manufactured of a composite dove tailed rib system, and adhered to a fiberglass backing. The boards are engineered to be attached directly to the joist structure of a floor. Its primary application and benefit to the tile industry is the setting of tile in an outdoor environment, particularly in areas with a freeze-thaw cycle. Installers in most of North America have never had a reliable solution to the problem of installing tile in a freeze–thaw area. Advancements in the tile and setting materials in recent years have made the installation of tile outdoors more of a reality than ever before, but the underlayment in which to set the tile has never been reliable or economical. SRSB provide our industry with product which is both economical and reliable.

To attempt to install tile outdoors in the past, the area would have to be specifically constructed for the application of tile. This included using much more materials in order to construct the deck or outdoor structure for the added weight of the 4” motor slab needed for the tile. Even with the added construction of the slab there was no guarantee the method would work in many areas of the country.

Where there was the threat of freeze–thaw cycles there were no reliable options to offer the installer. In the TCNA handbook 08” (for the exterior installation of tile in a deck, balcony or roof application), sections F103-07 and F104-07 under the sub- category of “limitations” reads as follows:

F103-07: Limitations

Although this is the best known method of installation for ceramic tile roof deck,

it is not reliable in areas where the mortar bed will be subjected to freeze-thaw cycles...

F104-07: Limitations

This method may not be reliable in areas where the installation will be subjected to freeze-thaw cycles...
By limiting the application of tile to outdoors areas with no freeze-thaw cycles, the tile industry has removed itself from 2/3 of the market for outdoor living areas in this country. This market is expanding beyond just the normal backyard, and now is a viable living area for the home. These areas include kitchens, outdoor dining areas and pools. The tile industry cannot afford to let this area of the construction market go unused.

SRSB have been fully tested for requirements set for an outdoor structure. These tests have been completed by the TCNA, Bowser- Morner and UL. The boards were tested for freeze-thaw resistance, deflection, expansion and contraction and flame spread. With each of these tests structural underlayment boards have received certification. Making it ideal for use in tiling outdoors.

What this means for the tile industry is tile will be considered an option for surfacing a deck. Tile can be just as reliable, if not more, than wood and composite surfaces. Tile also gives the added benefit of design and variety. Tile also provides the home owner with longevity and a maintenance free deck, which is as easy to clean as mopping the kitchen.

The application of SRSB is very simple. It does not require any alterations to the joist structure of the deck. The industry standard for decks is 16” on centers. A 16” on center deck will support 40lbs of dead weight per square foot. SRSB fully, loaded with tile, average 8lbs of dead weight per square foot. This is well under the capacity of a standard deck. The boards also received a rating of “Extra Heavy” after completing the Robinson Floor test. This means it is strong enough for industrial and heavy commercial applications.

Not only does the structure not need to be altered, but there is no special training, steps or tools to apply SRSB. The boards can be cut with a wet saw or circular saw with a masonry blade. The boards have to be laid across two joist spans, and any seams must be staggered. Each board is attached to the next with a tongue and groove clip. The boards are attached using 1 ¼” coated screw. There is no need for pre-drilling.

Once the boards are attached to the joist structure, a 1/4” mortar bed is screeded between the board’s ribs. Each rib is designed with mechanical lock to insure the mortar bed’s stability. The mortar used must be recommended for outdoor use and have a freeze-thaw rating.

After the mortar has been screeded level with the ribs and allowed to cure, a waterproof membrane can be applied. This is not a necessary step on all applications, but is needed if the balcony or deck is over occupied space.

After the waterproofing has dried, or in the cases that waterproofing is not necessary the mortar has cured, the thinset can be applied. The thinset needs to be 118.4 ansi or above, and must be recommended for outdoor applications in freeze-thaw areas. The tile must be porcelain, and also recommended for freeze-thaw applications.

When the thinset has cured the tile can be grouted. The grout must me for outdoor use in freeze thaw areas. These applications used with SRSB are standard for the tiling industry.
The inclusion of structural ribbed self-supporting boards in the TCNA handbook as one of the recommended installation methods for the application of tile outdoors can only improve the tile industry as a whole. From the installers to the manufacturers of the tile and setting materials, everyone will benefit from it being introduced into the handbook. By adding SRSB the industry does not restrict itself to areas where there are no freeze-thaw cycles. There are very few areas on the continent which will not be able to be included as area where tile can be applied outdoors. This is only made possible by structural ribbed self-supporting boards.
<table>
<thead>
<tr>
<th>Temperature (°F)</th>
<th>Length at Room Temp (inches)</th>
<th>3.969 inches</th>
<th>Temperature Difference (°F)</th>
<th>Length of Specimen at Room Temp (inches)</th>
<th>Change in Length of Specimen due to Heating (in)</th>
<th>Coefficient of Linear Thermal Expansion (in/in per °F)</th>
</tr>
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<td></td>
</tr>
</tbody>
</table>

3.969 inches Length at Room Temperature

T Temperature Difference

L Length of Specimen at Room Temperature

DL Change in Length of Specimen due to Heating

\[ a = \frac{DL}{L \times T} \]

**THERMAL EXPANSION**

Coefficient of Linear Thermal Expansion per °F as a function of Temperature.
TEST REQUESTED BY: North American Tile & Tool  
Attn: Brian Turner  
1965 International Way  
Hebron, KY 41048

TEST SUBJECT MATERIAL: Identified by client as: 3/8" thick TI Proboard

TEST DATE: 12/15/06-12/18/06

TEST PROCEDURE: ASTM C627: "A Standard Test Method for Evaluating Ceramic Floor Tile Installation Systems Using the Robinson-Type Floor Tester"

Materials:

A thin-set installation over a 3/8" thick TI Proboard base was prepared using the following materials:

1) 3/8" thick TI Proboard channels (secured with Hi Lo RockOn screws)  
2) Hydroment Polymer Modified Thin-Set Mortar  
3) Crossville Ceramics 12" x 12" Porcelain tiles (¼" Grout Joints)  
4) Hydroment Ceramic Tile Grout (sanded) with Hydroment 425 Acrylic Admixture

Base and Underlayment:

The Proboard channels were snapped together and screwed (with the long dimension perpendicular to the joists) to three 2" x 2" joists spaced 24" O.C. to simulate the support provided in an actual installation. The screws were spaced four inches apart.

Thin-set mortar, mixed with water per manufacturer’s instructions, was troweled over the Proboard channels, filling the channels with the flat side of a 1/4" x 3/8" U-notched trowel. Immediately afterwards, additional thin-set was added, and ridges were pulled over the channels with the notched side of the trowel.
Tile and Grout:

Thin-set mortar, mixed with water per manufacturer’s instructions, was troweled with the flat side of a 1/4” x 3/8” U-notched trowel over the Proboard channels. Immediately additional thin-set was added, and ridges were pulled over the channels with the notched side of the trowel.

The porcelain tiles were set in the thin-set by pressing down and sliding the tiles in a direction perpendicular to the combed ridges. After the tiles were installed, the thin-set was allowed to cure for 24 hours before grouting.

Sanded grout, mixed with admixture, was forced into the 1/4” grout joints with a rubber float. Excess grout was removed with the edge of the float by holding the float at a 90° angle. The grout was allowed to set up for approximately 20 minutes before the installation was cleaned with a sponge and clean water. The grouted installation was subsequently allowed to cure for 28 days.

At the end of the cure period, the installation was subjected to load cycling as defined in ASTM C-627. The deflection of the channels was measured under the wheel path, midway between the 24” O.C. joists.

TEST RESULTS:

The installation completed fourteen cycles with no evidence of damage to the tiles or grout joints.

* All evaluation criteria were based on 8 tiles and 8 grout joints in the wheel path of the Robinson-Type Floor Tester.

CONCLUSION:

In accordance with the Performance-Level Requirement Guide of the 2006 Handbook for Ceramic Tile Installation, page 15 the installation is classified as “EXTRA HEAVY” for “extra heavy and high-impact use in food plants, dairies, breweries, and kitchens”.

Virgil Irick
Director of Laboratory Services

Date 12/22/16
INTERIOR WALLS OVER WOOD OR METAL STUDS

W245-16

- Wood or Metal Studs
- Coated Glass Mat Water-Resistant Gypsum Backer Board

Recommended Uses
- For interior walls over wood or metal studs.

Environmental Exposure Classifications
- Res1, 2; Com1, 2.
- For Res3 and Com3, see B419 Stone and B420 Stone.
- For installations that may be exposed to staining and/or chemical attack, specify tile and grout suitable for exposure. Consult product manufacturers; see also Product Selection Guides.

Limitations
- Maximum stud spacing 16" on center.
- Not for areas exposed to temperatures exceeding 125°F.

Membrane Options
- A waterproof membrane (A118.10) may be specified to prevent moisture intrusion through seams, corners, fasteners, and other penetrations and to protect adjacent building materials. Follow backer board and membrane manufacturer’s waterproofing requirements. Specifier shall indicate if complete waterproofing is required, including base flashing and treatment at other termination points.
- Check with membrane manufacturer for suitability for applicable conditions, as not all membranes are suitable for steam, high-temperature and/or chemical exposure, or exterior use.

Requirements
- Wood studs—dry and well-braced, minimum depth 3-1/2".
- Metal studs—well-braced; 20 gauge (0.033") or heavier; minimum depth 3-1/2" for residential applications or 3-5/8" for commercial applications.
- Caulk or seal penetrations, corners, and abutments to dissimilar materials with flexible sealant.
- Minimum grout joint width—1/16." When glass tile is used, consult glass tile manufacturer for tile suitability over non-absorbptive surface.

Preparation by Backer Board Installers
- Maximum allowable variation in the tile substrate—1/8" in 10' from the required plane when measured from the high points in the surface.
- Fit ends and edges of panels, including in corners.
- Tape seams and corners with 2" alkali-resistant glass fiber mesh tape and cementitious bonding material, and skim coat over fastener heads, unless waterproofing has been applied.
- Center backer board end or edge joints on framing and stagger joints in adjacent rows so four corners do not come together within the same plane. Space panel ends and edges in accordance with manufacturer’s recommendations.

Materials
- Multiple options exist for membranes, mortars, grouts, and other materials and MUST BE CLEARLY SPECIFIED to be included. If not specifically indicated, optional materials are not included and mortar/grout choice defaults to minimum performance specification indicated. Consider each system component and intended use to determine minimum requirements and to specify options.
- Natural stone tile—see Natural Stone Tile Selection and Installation Guide, and consult supplier for application suitability.
- Cementitious grout—ANSI A118.6 or better or ISO CG1 or better. Consider unsanded grout for soft or semisoft stones such as limestone, travertine, marble, onyx, or similar.
- Cementitious bond coat:
  - When a waterproof membrane is not used—ANSI A110.4 or better or ISO C2S1 or better.
  - When a waterproof membrane is used—ANSI A118.4 or better or ISO C2S1 or better unless ANSI A118.1 or ISO C1 is recommended by membrane manufacturer.
  - Use white for light-colored marble, limestone, and other stones where staining or darkening from grey setting materials is possible.
- Epoxy bond coat, when used—ANSI A118.3 or ISO R1 or better. See Water Sensitivity and Fiberglass Mesh Reinforced Stone in the Natural Stone Tile Selection and Installation Guide.
- Waterproof membrane, when used—ANSI A118.10.
- Coated glass mat, water-resistant gypsum backer board—ASTM C1178.
- Fasteners—noncorrosive and nonoxidizing.

*USE OF A MEMBRANE IS OPTIONAL. SEE MEMBRANE OPTIONS.
• Fasteners meeting ASTM F2329-05 required in wet areas.
• 2" alkali-resistant glass fiber mesh tape.
• Flexible sealant—ASTM C920.
• Metal studs—ASTM C645.

**Materials for Green/Sustainable Design**
• See Green Building Standards and Green Product Selection Guide and consult manufacturers and suppliers for product sustainability and contribution to green building design.
• Consider specifying installation materials that meet ANSI A138.1, the *American National Standard Specifications for Sustainable Ceramic Tiles, Glass Tiles, and Tile Installation Materials*.

**Preparation by Other Trades**
• Wall framing shall meet the general framing requirements of ANSI A108.11-4.0–4.3.

**Movement Joint (architect must specify type of joint and show location and details on drawings)**
• Movement joints—mandatory according to EJ171.

**Installation Specifications**
• Coated glass mat water-resistant gypsum backer board—manufacturer’s directions.
• Tile—ANSI A108.5 or A108.6.
• Cementitious grout—ANSI A108.10.
• Movement Joints—EJ171 and ASTM C1193.

**Notes**
• As the tile size increases, there is less tolerance for variation in the substrate from the required plane. Epoxy bond coat thickness must be thin and uniform; therefore, substrate flattening may be required when epoxy bond coat is used.
• When unsanded grout is used, grout joint width must be 1/8” (nominal) or less.

- Liquid applied waterproof membranes, when used, will require extended cure time.

*(apply to ceramic and stone versions)*
INTERIOR WALLS OVER WOOD OR METAL STUDS

W248-16

• Wood or Metal Studs
• Glass Mat Water-Resistant Gypsum Backer Board
• Natural Stone Tile

Recommended Uses
• For interior walls over wood or metal studs.

Environmental Exposure Classifications
• Res1; Com1.
• For installations that may be exposed to staining and/or chemical attack, specify tile and grout suitable for exposure. Consult product manufacturers; see also Product Selection Guides.

Limitations
• Maximum stud spacing 16" on center.
• Not for areas exposed to temperatures exceeding 125°F.

Requirements
• Wood studs—dry and well-braced, minimum depth 3-1/2".
• Metal studs—well-braced; 20 gauge (0.033") or heavier; minimum depth 3-1/2" for residential applications or 3-5/8" for commercial applications.
• Caulk or seal penetrations, corners, and abutments to dissimilar materials with flexible sealant.
• Minimum grout joint width—1/16".

Preparation by Backer Board Installers
• Maximum allowable variation in the tile substrate—1/8" in 10' from the required plane when measured from the high points in the surface.
• Fit ends and edges closely to eliminate gaps between panels, including in corners.
• Tape seams and corners with 2" alkali-resistant glass fiber mesh tape and skim coat with cementitious bonding material.
• Center backer board end or edge joints on framing and stagger joints in adjacent rows so four corners do not come together within the same plane. Space panel ends and edges in accordance with manufacturer’s recommendations.

Materials
• Multiple options exist for membranes, mortars, grouts, and other materials and MUST BE CLEARLY SPECIFIED to be included. If not specifically indicated, optional materials are not included and mortar/grout choice defaults to minimum performance specification indicated. Consider each system component and intended use to determine minimum requirements and to specify options.
• Natural stone tile—see Natural Stone Tile Selection and Installation Guide, and consult supplier for application suitability.
• Cementitious grout—ANSI A118.6 or better. Consider unsanded grout for soft or semisoft stones such as limestone, travertine, marble, onyx, or similar.
• Cementitious bond coat:
  • ANSI A118.4 or better or ISO C2 or better.
  • Use white for light-colored marble, limestone, and other stones where staining or darkening from grey setting materials is possible.
• Epoxy bond coat, when used—ANSI A118.3 or ISO R1 or better. See Water Sensitivity and Fiberglass Mesh Reinforced Stone in the Natural Stone Tile Selection and Installation Guide.
• Glass mat, water-resistant gypsum backer board—ASTM C1658.
• Fasteners—noncorrosive and nonoxidizing.
• 2" alkali-resistant glass fiber mesh tape.
• Flexible sealant—ASTM C920.
• Metal studs—ASTM C645.

Materials for Green/Sustainable Design
• See Green Building Standards and Green Product Selection Guide and consult manufacturers and suppliers for product sustainability and contribution to green building design.
• Consider specifying installation materials that meet ANSI A138.1, the American National Standard Specifications for Sustainable Ceramic Tiles, Glass Tiles, and Tile Installation Materials.

Preparation by Other Trades
• Wall framing shall meet the general framing requirements of ANSI A108.11-4.0–4.3.

Movement Joint (architect must specify type of joint and show location and details on drawings)
• Movement joints—mandatory according to EJ171.

Installation Specifications
• Glass mat water-resistant gypsum backer board—manufacturer’s directions.
• Tile—ANSI A108.5 or A108.6.
**LIGHTING AND TILE INSTALLATIONS**

**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 on the wall, are popular techniques for producing dramatic room lighting effects. However, when proper backing surfaces, installation materials and methods, and location of light fixtures sources are not carefully coordinated, these lighting techniques may produce shadows and undesirable effects with ceramic tiles, particularly when light strikes the tile surface at a low or nearly flat angle (i.e., nearly parallel to the tile surface.) Similar shadows can be created from natural light from windows and doors side lighting interior walls and floors, and when light shines at that angle through windows and doors. a low angle on exterior walls and floors, as commonly occurs in the early morning and evening.

**Exterior**
When natural or artificial light shines on exterior walls and floors

Because such at a flat low angle lighting almost parallel to tile surfaces highlights and exaggerates normal and acceptable inconsistencies in the tile and tilework, are highlighted by shadows that exaggerate these conditions. the shadow-producing light is often referred to as “critical light” or “critical lighting.” Some of the allowable and acceptable characteristics of tile and tilework that can be highlighted or exaggerated by critical lighting include:

- Die release lines on the edges of tiles
- Difference in appearance between a factory-edge of a tile versus an edge that has been field cut by scoring, grinding, or wet cutting
- Allowable warpage in the tile (see ANSI A137.1 for definition and allowances)
- Allowable lippage (see ANSI A108.02 for definition and allowances)
- Allowable variation in height between field tile and trim pieces and/or accent tiles, whether such are or are not part of the same tile line.

In addition, critical lighting can worsen the appearance of tilework that does not meet the finish flatness and lippage tolerances set forth in ANSI A108.02, which can occur in a proper installation under certain specified conditions:

- tiled floors sloping to drains (see ANSI A108.02)
- when the project owner does not provide a substrate that meets required flatness tolerances for tile nor contract the tile contractor to correct substrate flatness defects (see ANSI A108.01 and “Disparity Between Concrete Flatness Tolerances Based on F-Numbers and the 10-foot Straightedge Method” in this Handbook)

To minimize the undesirable effects of critical lighting:

- Place lighting such that it will decrease or eliminate the undesirable effects of critical lighting, and install permanent lights prior to tile installation to provide the installer the maximum opportunity to reduce undesirable shadows.
- Reduce the amount of inherent or allowable lippage by ensuring substrates meet required flatness tolerances for ceramic tile, for example by: specifying a mortar bed, pourable underlayment, or other tile substrate that facilitates a flat tile
installation; including adequate allowance in the tile specification for substrate preparation; and specifying the trade
responsible for required alterations to a substrate that does not meet flatness tolerances for tile.

- Reduce the amount of inherent or allowable lippage by specifying tile with minimal warpage, such as rectified tile per ANSI
  A137.1.

- Minimize the effect of lippage due to warpage by specifying wider grout joints, cushioned or beveled edge tile, and tile sizes
  and patterns that minimize lippage due to warpage, for example brick-joint patterns with 25% or 33% offset (see ANSI
  A108.02).
MEMBRANE SELECTION GUIDE

Membrane Types

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.

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 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.

Vapor Retarder Membranes

No material can completely eliminate water vapor transmission. However, the transmission of vapor can be reduced 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 board to retard moisture and vapor transmission into the wall cavity. Examples of vapor retarder membranes include: roofing felt, reinforced asphalt paper, asphalt laminated paper, polyethylene sheeting, chlorinated polyethylene (CPU) sheeting, and polyvinyl chloride (PVC) membrane.

Waterproof Membranes

In addition to built-up membranes, single-ply membranes, and nonmetallic and lead or copper waterproofing, there are also waterproof membranes (ANSI A118.10) available for use with both vertical and horizontal thin-bed and thick-bed installations of tile, which may be installed by tile trades.

Among these are single- or multi-component membranes applied in liquid/paste form, which cure into continuous membranes and membranes applied in flexible sheet form. Some of these membranes have integral reinforcing fabrics for tensile strength and minor crack-bridging properties. Others are designed to be used as a combination waterproofing and setting material for the tile.

Depending upon the type of waterproofing membrane, manufacturers may require that tile products be installed on a reinforced portland cement mortar bed applied over the membrane; directly on the membrane with dry-set or latex/polymer modified portland cement mortar; or bonded to the membrane using a troweled application of the waterproofing membrane product.

Low Perm Waterproof Membranes

No material can completely eliminate water vapor transmission. However, the transmission of vapor can be reduced through the use of a low perm waterproof membrane. Low perm waterproof membranes are waterproof membranes (ANSI A118.10) with a water vapor permeance of less than 0.5 perms when tested per ASTM E96 Standard Test Methods for Water Vapor Transmission of Materials, Procedure E (desiccant method at 100°F) and 90% relative humidity. Not all waterproof membranes meeting ANSI A118.10 are low perm waterproof membranes.

Crack Isolation Membrane

Crack isolation membranes (ANSI A118.12) for thin-bed ceramic, glass, and stone installations act to isolate the tile from minor in-plane substrate cracking. Membranes covered by this definition are bonded to a variety of manufacturer-approved substrates covered by ANSI specifications. In some cases, the trowel-applied products can be used as the adhesive for the tile. Other products within the scope of this category are allowed to cure or are applied as sheet goods and are then used as the substrate for the tile.

Membranes may be sensitive to naturally occurring moisture and alkalinity when used over cement and gypsum-based substrates. Consult manufacturer for acceptable limits of moisture and alkalinity.
Uncoupling Membrane

An uncoupling membrane is a plastic membrane system geometrically configured to provide air space between the tile and the substrate to allow independent movement between the two and limit the transfer of stresses. These membranes are not characterized by ANSI or ISO standards. The uncoupling membrane must achieve 50 psi or greater shear bond strength in 7 days per the test method in ANSI A118.12 Section 5.1.3. Consult the manufacturer’s written literature for specific application details.

Bonded Sound Reduction Membranes

Bonded sound reduction membranes are intended to reduce floor-to-floor impact insulation class (IIC) sound. The higher the IIC or delta value, the less transmission of impact noise that is allowed by the membrane. Bonded sound reduction membranes must reduce impact noise (increase IIC) by at least 10 IIC points when tested to ASTM E2179, in accordance with ANSI A118.13. The Uniform Building Code requires a minimum IIC of 50 for sound reduction membranes, and local building codes may require even more stringent minimum acceptable IIC values.

Bonded sound reduction membranes may be trowel applied, sheet, or composite membranes that are bonded to a suitable substrate so that tile can be bonded directly to the membrane.

Material specifications are contained in ANSI A118.13.

Considerations When Using Membranes

Where membranes are used, mortar cure times will be extended. See Setting Material Selection Guide.

Membranes and/or membrane adhesives and primers may be sensitive to naturally occurring moisture and alkalinity when used over cement and gypsum-based substrates. Consult manufacturer for acceptable limits of moisture and alkalinity.
Note
Specifications in this Handbook for the materials used to adhere 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 setting 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.

Introduction
The following are the most widely used materials for setting ceramic, glass, and natural stone tiles. Each possesses specific qualities that make it suitable for installing tile over certain backings or under a given set of conditions.

The conventional portland cement mortar method, including the one coat method, is the only recognized thick-bed method. All others are thin-bed methods and are covered by existing trade jurisdictional decisions of record. Dry-set mortars and latex-Portland cement mortars can be used in lieu of neat cement as a 1/16”-thick bond coat to bond ceramic, glass, and natural stone tiles to a Portland cement mortar bed that is still workable. They can also be used on a cured Portland cement mortar bed (minimum 3/32” thickness after tile is embedded) according to ANSI A108.1B.

A neat cement bond coat can be used only when the Portland cement mortar is still workable (A108.1A). Absorptive ceramic and stone tiles must be soaked before setting on a mortar bed that is still workable when using a neat Portland cement bond coat. Under normal job conditions, a minimum of 20 hours cure at 70°F is adequate, but longer mortar bed cures of up to 10 days are desirable. When epoxy mortars, epoxy adhesives, furan, or organic adhesives are used, the mortar bed must be dry.

To ensure practical and satisfactory installations, the cement mortar bed to receive the tile, whether left workable or allowed to harden, is to be applied by the tile contractor who must establish all the finished dimensions at the time this bed is applied.

Non-cement setting materials such as epoxies and furans offer properties not possible with cement-based mortar (e.g., chemical resistance, quick setting times). However, special skills on the part of the tile setter may be required.

TYPES OF SETTING MATERIALS

Neat Cement and Portland Cement Mortar

Portland cement mortar is a mixture of Portland cement and sand, roughly in proportions of 1:5 for floors, and of Portland cement, sand, and lime, in proportions of 1:5:1/2 to 1:7:1 for walls.

Portland cement mortar is suitable for most surfaces and ordinary types of installation. A mortar bed, up to 2” in thickness, facilitates accurate slopes or planes in the finished tilework on floors and walls.

The mortar bed can be modified with the inclusion of a latex/redispersible polymer per the manufacturer’s directions as part or all of the liquid portion of the mixture to enhance certain performance properties.
There are two equivalent methods recognized for installing ceramic, glass, and natural stone tiles with a portland cement mortar bed on walls, ceilings, and floors. They are: the method covered by ANSI A108.1A, which requires that the tile be set on a mortar bed that is still workable; and the method covered by ANSI A108.1B, which requires that the tile be set on a cured mortar bed with dry-set or latex/polymer modified portland cement mortar. Absorptive ceramic and stone tiles must be soaked before setting on a mortar bed that is still workable when using a neat portland cement bond coat.

Portland cement mortars can be bonded to concrete floors, backed with membranes and reinforced with wire mesh or metal lath, or applied on metal lath over open studding on walls. They are structurally strong, are not affected by prolonged contact with water, and can be used to plumb and square surfaces installed by others.

Suitable backings when properly prepared are: brick or cement masonry, concrete, wood or steel stud frame, rough wood floors, plywood floors, foam insulation board, gypsum board, and gypsum plaster. The one coat method may be used over masonry, plaster, or other solid backing that provides firm anchorage for metal lath.

Complete installation and material specifications are contained in ANSI A108.1A, A108.1B, and A108.1C. These mortars are not characterized by ISO criteria.

**Dry-Set Mortar**

Dry-set mortar is a mixture of portland cement with sand and additives imparting water retentivity that is used as a bond coat for setting tile.

Dry-set mortar is suitable for thin-bed installations of ceramic and natural stone tiles over a variety of surfaces. It is used in one layer nominally between 3/32" and 1/4" after tiles are embedded, has excellent water and impact resistance, is water-cleanable, nonflammable, good for exterior work, and does not require soaking of tile.

Dry-set mortar is available as a factory-sanded mortar to which only water need be added. Cured dry-set mortar is not affected by prolonged contact with water, but does not form a water barrier. It is not intended to be used in truing or leveling the work of others.

Suitable backings, when properly prepared, include plumb and true masonry, concrete, gypsum board, cement backer board, fiber-cement backer board, cementitious coated foam backer board, cured portland cement mortar beds, brick, ceramic tile, and dimension stone. Consult membrane and setting material manufacturer for use over uncoupling membranes, waterproof membranes, and crack isolation membranes.

Complete installation and material specifications are contained in ANSI A108.5 and ANSI A118.1. For applicable ISO material specifications, see ISO C criteria.

**Latex/Polymer Modified Portland Cement Mortar**

Latex/polymer modified portland cement mortar is a mixture of portland cement, sand, and special latex/polymer additive that is used as a bond coat for setting tile.

The uses of latex/polymer modified portland cement mortar are similar to those of dry-set mortar. Latex/polymer additives for use in thin-bed portland cement 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, latex/polymer modified portland cement mortar is required for the installation of porcelain tile.

When latex/polymer modified portland cement mortar is used to install ceramic, glass, and natural stone tiles in an area that
may not thoroughly dry out in use (e.g., swimming pools and gang showers, etc.) or where initial drying is inhibited (between
tile and impervious substrates), it is recommended that the completed installation be allowed to dry out thoroughly before
exposure to water. This drying period can range from 14 to more than 60 days depending upon the temperature and humidity
and other climatic conditions, and whether the installation is interior or exterior. Consult setting material manufacturer for
minimum set times before grouting tile or allowing traffic, water exposure, or submersion.

When installing 8" x 8" or larger impervious tile over a waterproof or crack isolation membrane, or other impervious substrate,
longer curing times will be required, excepting when rapid curing mortars are used. With the same exception, cure times will
also be extended with narrow grout joints and when high performance grouts such as those meeting ANSI A118.3, A118.5, and
A118.7 are used. When one or more of these conditions exists, delaying grouting will allow better evaporation of excess
moisture.

When longer cure times are required on floors, extend the amount of time before allowing traffic on the floor.

A rapid-setting latex/polymer modified cement mortar may need to be specified for faster curing. Consult manufacturer for
recommendations and requirements. Because latices-polymers vary considerably, the directions of the latex/polymer mortar
manufacturer must be followed explicitly.

Not all latex/polymer modified portland cement mortars are suitable for wet areas. Consult manufacturer for suitability for
intermittent and submerged applications.

Complete installation and material specifications are contained in ANSI A108.5 and ANSI A108.12 installation
standards and ANSI A118.4, A118.11, and A118.15 material standards. For applicable ISO material specifications, see ISO C
criteria.

**Exterior Glue Plywood (EGP) Latex Portland Cement Mortar**

EGP mortar is a latex/polymer modified portland cement mortar specifically for bonding ceramic, glass, and natural stone tiles
to exterior glue plywood. When added in latex form, the polymer is added as a replacement for part or all of the gauging water
in accordance with the manufacturer’s instructions.

Complete installation and material specifications are contained in ANSI A108.12 and ANSI A118.11. For applicable ISO
material specifications, see ISO C, P criteria.

**Dry Set Mortar for Large and Heavy Tile (LHT Mortar), formerly Medium Bed Mortar**
LHT mortar (formerly medium bed mortar) is a thin-set bonding mortar for ceramic and stone tile, formulated by the manufacturer so as to minimize slump and facilitate a thicker bond coat as compared with a bonding mortar that is not labeled as dry set mortar for large and heavy tile, or LHT mortar (formerly medium bed mortar). It is intended to be used as a bond coat 3/32" thick (nominal) to 1/2" thick (nominal) after the tile is embedded. LHT mortar (formerly medium bed mortar) is declared as such by its manufacturer based on its characteristics; there are no ANSI or ISO standards specific to this type of mortar. Rather, LHT mortar (formerly medium bed mortar) must meet the requirements of an existing ANSI mortar standard (A118.1, A118.4, A118.11, or A118.15) or ISO mortar standard (C1 or C2).

The characteristics of LHT mortar (formerly medium bed mortar) make it useful for setting heavy tiles (generally, tiles that are 5 pounds/square foot or heavier) and tiles with ungauged thickness. It is also useful and commonly used for setting large tiles (tiles with at least one side greater than 15" long) because, when setting such tiles, larger trowels are used and needed to apply enough bonding mortar to achieve mortar coverage requirements. For large tiles, a thicker bond coat is often required to achieve mortar coverage requirements if there is warpage in the tile, which necessitates additional bonding mortar to eliminate voids under the tile where the tile’s curvature creates a larger space between tile and substrate, typically in the center of the tile. Refer to ANSI A137.1 for allowable warpage for ceramic tile.

NOTE TO SPECIFIER: LHT mortar (formerly medium bed mortar) is not intended for truing or leveling substrates or the work of others. Where substrate variation exceeds allowances, LHT mortar (formerly medium bed mortar) cannot be used to remedy such, because the application would exceed the limitations of the mortar. LHT mortar (formerly medium bed mortar) is intended to be used to install tile per ANSI A108.5, the installation standard for installing tile by the thin-bed method. Accordingly, LHT mortar (formerly medium bed mortar) is a product, not an installation method. Project plans and specifications that call for or refer to setting tile by a “medium bed method” or “large and heavy method” or that call for the use of bonding mortar to level, flatten, or fill substrates or to create slopes or transitions between finish floor heights do not conform to tile industry standards or norms.

**Epoxy Mortar**

Epoxy mortar is a mortar system designed for chemical resistance employing epoxy resin and epoxy hardener portions. Epoxy mortar is suitable for thin-bed installations of ceramic and natural stone tiles where chemical resistance of floors, high bond strength, and high impact resistance are important considerations. High-temperature-resistant formulas are also available. Acceptable substrates, when properly prepared, include concrete, wood and plywood, steel plate, ceramic tile, and stone tile. Application is made in one thin layer. Pot life, adhesion, water-cleanability before cure, and chemical resistance vary with manufacturer. Epoxy grout is also available. See Grout Selection Guide.

Complete installation and material specifications are contained in ANSI A108.6 and ANSI A118.3. For applicable ISO material specifications, see ISO R criteria.

**Modified Epoxy Emulsion Mortar**

Modified epoxy emulsion mortar is a mortar system employing emulsified epoxy resin and hardener with portland cement and silica sand. Modified epoxy emulsion mortars are formulated for thin-bed installations of ceramic and natural stone tiles on floors and walls, interior and exterior. Their features include high bond strength, ease of application, little or no shrinkage, and economical epoxy application. They are not designed for chemical resistance.

Recommended uses include residential floors over substrates such as cementitious backer units and concrete. Where complete and firm support under the tiles is mandatory, 95% coverage is required. This material is recommended by most manufacturers as a bond coat or setting material. Some also recommend it for grouting.
Complete installation and material specifications are contained in ANSI A108.9 and ANSI A118.8. For applicable ISO material specifications, see ISO R criteria.

**Furan Resin Mortar**
Furan resin mortar is a mortar system designed for chemical resistance consisting of furan resin and furan hardener portions. Furan mortar is suitable for thin-bed installations of ceramic tile where chemical resistance of floors is an important consideration. Acceptable subfloors, when properly prepared, include concrete, wood and plywood, steel plate, and ceramic tile. They are typically not used in the installation of glass or stone tiles. Furan grout is also available. See Grout Selection Guide.

Complete installation and material specifications are contained in ANSI A108.8 and ANSI A118.5. For applicable ISO material specifications, see ISO R criteria.

**Epoxy Adhesive**
Epoxy adhesive is an adhesive system employing epoxy resin and epoxy hardener portions. Epoxy adhesive is formulated for thin-bed installations of ceramic and stone tile on floors, walls, and counters. It is designed primarily for high bond strength and ease of application and not for optimum chemical resistance. However, its chemical and solvent resistance tends to be better than that of organic adhesives.

Complete installation and material specifications are contained in ANSI A108.4 and ANSI A118.3. For applicable ISO material specifications, see ISO R criteria.

**Spot-Bonding Epoxy**
Spot-bonding epoxy is a multi-component high-strength epoxy adhesive designed for spot-bonding ceramic tile and stone.

Refer to ANSI A118.3. For applicable ISO material specifications, see ISO R criteria.

**Organic Adhesive**
Organic adhesive is a prepared organic material for interior use only, ready to use with no further addition of liquid or powder, which cures or sets by evaporation. Organic adhesives are suitable for setting ceramic tile on floors, walls, and countertops, where surfaces are appropriate and properly prepared in accordance with adhesive manufacturer’s directions. Adhesives are applied in one thin layer with a trowel, first using the flat edge for continuous coverage and then the notched edge for uniform thickness. Where leveling or truing is required, an underlayment is used.

Adhesives are not suitable for swimming pools, exteriors, or areas exposed to temperatures exceeding 140ºF. They supply some flexibility to the tile facing. Bond strength varies greatly among the numerous brands available. Solvents in some adhesives are irritating to some persons, and some adhesives are flammable.

Complete installation and material specifications are contained in ANSI A108.4 and ANSI A136.1. For applicable ISO material specifications, see ISO D criteria.
Subsurface Tolerances and Large Tile
As tile size increases, the effect of substrate irregularities is compounded. When specifying tile with any edge longer than 15, consider specifying a recessed substrate and a mortar bed (thick-set) installation method to minimize lippage that results when a thin-bed method is specified but subfloor flatness requirements are not met. Project specifications shall include a specific and separate requirement to bring the subsurface into compliance if a thin-bed method is specified but subfloor does not meet the flatness requirements. See also: Disparity Between Concrete Flatness Tolerances Based on F-Numbers and the 10-foot Straightedge Method.

Subsurface-Substrate Tolerances and Large Tile
As tile size increases, the effect of substrate irregularities is compounded. If specifying a thin bed method, project specifications should include a specific dollar allowance to bring the substrate into compliance if the substrate does not meet the required flatness tolerance. When specifying tile with any edge longer than 15, consider specifying a recessed substrate and a mortar bed (thick-set) installation method to produce a substrate that meets the more stringent flatness requirement for large format tiles. Project specifications shall include a specific and separate requirement to bring the subsurface into compliance if a thin-bed method is specified but subfloor does not meet the flatness requirements. If the substrate does not meet minimum requirements, there is no “medium bed installation method” that can be used to flatten the substrate while installing the tile, as mortar (including LHT mortar) is not intended for truing or leveling substrates or the work of others. See also: “Disparity Between Concrete Flatness Tolerances Based on F-Numbers and the 10-foot Straightedge Method” and “Dry Set Mortar For Large and Heavy Tile (LHT Mortar), Formerly Medium Bed Mortar.”
Stephanie Samulski  
Tile Council of North America  
100 Clemson Research Blvd.  
Anderson, SC. 29625

Re: 2016 Handbook Submission

I would like to submit a global change and request for withdrawal of all reference to uncoupling and uncoupling methods including the definition from the TCNA Handbook.

Background

As a member of the Handbook and associated committees for many years I am intimately familiar with the history of many methods currently listed in the TCNA Handbook. I have been fortunate to be a part of the TCA Handbook growth from 39 pages when first joining the committee to the current 300+ pages. I was an early champion of the uncoupling system as manufactured by Schluter Systems and Blanke. The committee had made many requests of Schluter Systems and Blanke for supporting documentation on their methods which they dutifully supplied at substantial expense. One of the other contingencies was that they strive to create a standard for their product category as had been done previously with thinsets, backer boards, waterproofing, and crack isolation. While I don’t recall the specific date, I do recall being in a meeting with former TCNA Executive Director Bob Daniels when I first joined the committee where this was made clear.

I have expressed my concern about the lack of a product standard with increasing frequency which peaked several years ago. My concern was due in no small part to the growth of defective product claims, product misrepresentations, and installation issues which have amounted to millions of dollars in losses to numerous parties except those who manufacture the uncoupling products. In attempt to placate this concern the MMSA committee on uncoupling membranes decided to add the requirement in the TCNA Handbook that uncoupling membranes should meet the 50 PSI or greater shear requirement under ANSI A118.12 as shown in method F148 for example. This is somewhat erroneous as some manufacturers of uncoupling membranes say their products are designed to shear from the substrate under duress. Still another says their uncoupling membrane is designed to NOT be bonded to the substrate. Thus this Handbook requirement is not consistent with their product performance claims.

Another example is method F 113A which states that an uncoupling membrane is suitable to use when subfloor movement is anticipated. Yet, there is no requirement that an uncoupling membrane meet the movement requirements under ANSI A118.12. Having performed independent claims related tests using the section 5.4 System Crack
Resistance Test; several products have failed to meet this performance criterion. Have had similar experiences with the 118.12-5.2 Point load test where the product failed to perform. Thus we are directing those who use the handbook to employ products which do not meet the referenced performance criteria.

The use of an A118.1 mortar to bond porcelain has long been controversial. Having done well over 100 shear bond tests I know it works with a premium A 118.1 product. However, those manufacturers that approve use of a 118.1 thinset to bond porcelain refuse to make any distinction by stating that only premium 118.1 products will perform in that capacity. I gave one uncoupling manufacture the opportunity to suggest a premium product at the bid stage of one large project. They declined because they did not want to risk the 175,000 s/f order. Their failure to make that distinction will now cost one of my clients 5.1 million dollars. Again, the membrane manufacture was not held accountable.

Conclusion and Subsequent Request

The current “uncoupling” product category includes many untested products with varying undocumented performance claims well outside that of the original products. In conversation with Dan Holcomb of Blanke Corporation, one of the companies supporting the original method request, he states they have not been asked to assist in developing a standard nor do they care if the methods remain in the handbook. The definition of uncoupling itself is no longer valid as some of the products in my possession have no airspace whatsoever and to say they are geometrically configured is questionable.

Because there are a growing number of “uncoupling “ products on the market making dubious and undocumented performance claims considerably outside those of the originally submitted products and supporting data, I wish to submit this request for removal of all methods and reference uncoupling membranes.

Respectfully

[Signature]

David M. Gobis


**Dry-Set Mortar**

Dry-set mortar is a mixture of portland cement with sand and additives imparting water retentivity that is used as a bond coat for setting tile.

Dry-set mortar is suitable for thin-bed installations of ceramic and natural stone tiles over a variety of surfaces. It is used in one layer nominally between 3/32" and 1/4" after tiles are embedded, has excellent water and impact resistance, is water-cleanable, nonflammable, good for exterior work, and does not require soaking of tile.

Dry-set mortar is available as a factory-sanded mortar to which only water need be added. Cured dry-set mortar is not affected by prolonged contact with water, but does not form a water barrier. It is not intended to be used in truing or leveling the work of others.

Suitable backings, when properly prepared, include plumb and true masonry, concrete, gypsum board, cement backer board, cementitious coated foam backer board, cured portland cement mortar beds, brick, ceramic tile, and dimension stone. Consult membrane and setting material manufacturer for use over uncoupling membranes, waterproof membranes, and crack isolation membranes.

Complete installation and material specifications are contained in ANSI A108.5 and ANSI A118.1. For applicable ISO material specifications, see ISO C criteria.

**Latex/Polymer Modified Portland Cement Mortar**

Latex/polymer modified portland cement mortar is a mixture of portland cement, sand, and special latex/polymer additive that is used as a bond coat for setting tile.

The uses of latex/polymer modified portland cement mortar are similar to those of dry-set mortar. Latex/polymer additives for use in thin-bed portland cement 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, latex/polymer modified portland cement mortar is required for the installation of porcelain tile.

When latex/polymer modified portland cement mortar is used to install ceramic, glass, and natural stone tiles in an area that may not thoroughly dry out in use (e.g., swimming pools and gang showers, etc.) or where initial drying is inhibited (between tile and impervious substrates), it is recommended that the completed installation be allowed to dry out thoroughly before exposure to water. This drying period can range from 14 to more than 60 days depending upon the temperature and humidity and other climatic conditions, and whether the installation is interior or exterior. Consult setting material manufacturer for minimum set times before grouting tile or allowing traffic, water exposure, or submersion.

When installing 8" x 8" or larger impervious tile over a waterproof or crack isolation membrane, or other impervious substrate, longer curing times will be required. A rapid-setting latex/polymer modified cement mortar may need to be specified for faster curing. Because latices vary considerably, the directions of the latex/polymer mortar manufacturer must be followed explicitly.

Not all latex/polymer modified portland cement mortars are suitable for wet areas. Consult manufacturer for suitability for intermittent and submerged applications.

Complete installation and material specifications are contained in ANSI A108.5 and ANSI A118.4. For applicable ISO material specifications, see ISO C criteria.

**Exterior Glue Plywood (EGP) Latex Portland Cement Mortar**

EGP mortar is a latex/polymer modified portland cement mortar specifically for bonding ceramic, glass, and natural stone tiles to exterior glue plywood. When added in latex form, the polymer is added as a replacement for part or all of the gauging water in accordance with the manufacturer's instructions.

Complete installation and material specifications are contained in ANSI A108.12 and ANSI A118.11. For applicable ISO material specifications, see ISO C, P criteria.

**Dry Set Mortar for Large and Heavy Tile (LHT Mortar), formerly Medium Bed Mortar**

LHT mortar (formerly medium bed mortar) is a thin-set bonding mortar for ceramic and stone tile, formulated by the manufacturer so as to minimize slump and facilitate a thicker bond coat as compared with a bonding mortar that is not labeled as dry set mortar for large and heavy tile, or LHT mortar (formerly medium bed mortar). It is intended to be used as a bond coat 3/32" thick (nominal) to 1/2" thick (nominal) after the tile is embedded. LHT mortar (formerly medium bed mortar) is declared as such by its manufacturer based on its characteristics; there are no ANSI or ISO standards specific to this type of mortar. Rather, LHT mortar (formerly medium bed mortar) must meet the requirements of an existing ANSI mortar standard (A118.1, A118.4, A118.11, or A118.15) or ISO mortar standard (C1 or C2).
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.

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.

Vapor Retarder Membranes

No material can completely eliminate water vapor transmission. However, the transmission of vapor can be reduced 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 board to retard moisture and vapor transmission into the wall cavity. Examples of vapor retarder membranes include: roofing felt, reinforced asphalt paper, asphalt laminated paper, polyethylene sheeting, chlorinated polyethylene (CPE) sheeting, and polyvinyl chloride (PVC) membrane.

Waterproof Membranes

In addition to built-up membranes, single-ply membranes, and nonmetallic and lead or copper waterproofing, there are also waterproof membranes (ANSI A118.10) available for use with both vertical and horizontal thin-bed and thick-bed installations of tile, which may be installed by tile trades.

Among these are single- or multi-component membranes applied in liquid/paste form, which cure into continuous membranes and membranes applied in flexible sheet form. Some of these membranes have integral reinforcing fabrics for tensile strength and minor crack-bridging properties. Others are designed to be used as a combination waterproofing and setting material for the tile.

Depending upon the type of waterproofing membrane, manufacturers may require that tile products be installed on a reinforced portland cement mortar bed applied over the membrane; directly on the membrane with dry-set or latex/polymer modified portland cement mortar; or bonded to the membrane using a troweled application of the waterproofing membrane product.

Low Perm Waterproof Membranes

No material can completely eliminate water vapor transmission. However, the transmission of vapor can be reduced through the use of a low perm waterproof membrane. Low perm waterproof membranes are waterproof membranes (ANSI A118.10) with a water vapor permeance of less than 0.5 perms when tested per ASTM E96 Standard Test Methods for Water Vapor Transmission of Materials, Procedure E (desiccant method at 100°F) and 90% relative humidity. Not all waterproof membranes meeting ANSI A118.10 are low perm waterproof membranes.

Crack Isolation Membrane

Crack isolation membranes (ANSI A118.12) for thin-bed ceramic, glass, and stone installations act to isolate the tile from minor in-plane substrate cracking. Membranes covered by this definition are bonded to a variety of manufacturer-approved substrates covered by ANSI specifications. In some cases, the trowel-applied products can be used as the adhesive for the tile. Other products within the scope of this category are allowed to cure or are applied as sheet goods and are then used as the substrate for the tile.

Membranes may be sensitive to naturally occurring moisture and alkalinity when used over cement and gypsum-based substrates. Consult manufacturer for acceptable limits of moisture and alkalinity.

Uncoupling Membrane

An uncoupling membrane is a plastic membrane system geometrically configured to provide air space between the tile and the substrate to allow independent movement between the two and limit the transfer of stresses. These membranes are not characterized by ANSI or ISO standards. The uncoupling membrane must achieve 50 psi or greater shear bond strength in 7 days per the...
Bonded Sound Reduction Membranes

Bonded sound reduction membranes are intended to reduce floor-to-floor impact insulation class (IIC) sound. The higher the IIC or delta value, the less transmission of impact noise that is allowed by the membrane. Bonded sound reduction membranes must reduce impact noise (increase IIC) by at least 10 IIC points when tested to ASTM E2179, in accordance with ANSI A118.13. The Uniform Building Code requires a minimum IIC of 50 for sound reduction membranes, and local building codes may require even more stringent minimum acceptable IIC values.

Bonded sound reduction membranes may be trowel applied, sheet, or composite membranes that are bonded to a suitable substrate so that tile can be bonded directly to the membrane.

Material specifications are contained in ANSI A118.13.
Maximum Allowable Deflection for Floor Systems and Substrates

Floor systems, whether wood framed or concrete, over which the tile will be installed using the appropriate TCNA method, according to the Floor Tiling Installation Guide, shall be in conformance with the International Residential Code (IRC) for residential applications, the International Building Code (IBC) for commercial applications, or applicable building codes. For ceramic tile installations maximum allowable floor member live load and concentrated load deflection for framed floor systems shall not exceed L/360, where “L” is the clear span length of the supporting member per applicable building code. For natural stone tile installations, maximum allowable floor member live load and concentrated load deflection for wood framed floor systems shall not exceed L/720, where “L” is the clear span length of the supporting member, per applicable building code.

The owner should communicate in writing to the project design professional and general contractor the intended uses of the tile installation, including in-service loads or information to allow a project design professional to calculate such. Project design professional and general contractor must make necessary allowances for the expected live load, concentrated loads, impact loads, and dead loads, including maximum allowable loads during construction and maintenance. When concentrated loads such as scissor lifts, pallet jacks, automobiles, forklifts, etc., will be utilized on a tile or stone floor, the project design professional shall include their use in the determination of the appropriate substrate. For the weight of the tile and setting bed (contribution to dead load), see Typical Weight of Tile Installation in the method being specified.

The tile contractor shall not be responsible for problems resulting from any structural subfloor installation not compliant with applicable building codes, unless structural subfloor was designed and installed by tile contractor, nor for problems from overloading. As tile is a finish applied to and relying upon the underlying structure, an inadequate substructure can cause a tile failure. In many cases, problems in the substructure may not be obvious, and the tile contractor cannot be expected to discover such and tile contractor shall not be responsible for designing flooring assembly, unless specifically engaged to do so in writing. Tile contractor cannot determine possibility of an overloaded condition.

In addition to deflection considerations, above-ground installations are inherently more susceptible to vibration. Consult grout, mortar, and membrane manufacturers to determine appropriate installation materials for above-ground installations. Crack isolation or uncoupling membranes—and higher quality setting materials can increase the performance capabilities of above-ground applications. However, these upgraded materials cannot mitigate structural deficiencies including floors not meeting code requirements and/or overloading or other abuse of the installation in excess of design parameters.

Natural Stone Tile Installations on Post-Tensioned Concrete

Because dynamic movements of post-tensioned slabs have proven problematic for directly adhered natural stone, F111 is the only method of installing natural stone tile over post-tensioned slabs, on-ground or above-ground.

Proper Spacing for Wood Subflooring and Wood Underlayments

Plywood subflooring, OSB subflooring, and plywood underlayment shall be installed with proper spacing between the sheets (typically 1/8," except if specified otherwise by the wood manufacturer). If the subfloor or underlayment is installed without proper spacing, this condition cannot be corrected by the tile installer. It is the responsibility of the project owner (or owner's subflooring or underlayment installer) to ensure proper spacing is used as failure to do so may not be obvious, and the tile installer cannot be expected to discover such. If expansion takes place in wood subflooring or underlayment installed without proper spacing, the tile installation could fail.

Natural Stone Tile Installations Over Wood Substrates

Two layers of structural wood panels are required on floors to receive stone tile when backer board will be used as the tile substrate. The MIA prohibits installation of stone tile over single-layer wood floor systems under backer board because of the discontinuity of the system at seams between the subfloor panels. If an unbonded mortar bed will be installed as the tile substrate, a single layer of wood subflooring is permitted.

Natural Stone Tile Installation Over Frame Construction

Strongbacks, bridging, or other load-sharing members may be required within a wood framed system to
F128-16
• On-Ground Young Concrete
• Uncoupling Membrane
• Ceramic Tile

Recommended Uses
• For tiling over young concrete on slab-on-ground construction where no bending stresses occur.

Service Rating
• Light commercial with 2” x 2” and larger tiles.
• Extra heavy with 12” x 12” and larger porcelain tiles.

Environmental Exposure Classifications
• Res1, 2, 3, 4, 5; Com1, 2, 3, 4, 5.
• For installations that may be exposed to staining, specify tile and grout suitable for exposure. Consult product manufacturers; see also Product Selection Guides.
• For installations that may be exposed to mild chemical attack, specify epoxy grout and tile suitable for exposure. Consult product manufacturers; see also Product Selection Guides.

Typical Weight of Tile Installation
• 6 pounds/square foot.
• Does not include weight of substrate. See Appendix B for assumptions, included materials, and their individual weights.

Limitations
• Not for use over above-ground structural slabs and other floors subject to movement and/or deflection.

Requirements
• Slab to be free of waxy or oily films and curing compounds.
• No standing water on slab during uncoupling membrane installation.
• Concrete must be cured sufficiently to support tile installation traffic as determined by the project design professional, construction manager, or general contractor.
• Check with membrane manufacturers for suitability for applicable conditions, as not all membranes are suitable for steam, high temperature, and/or chemical exposure, exterior use, use over above-ground structural slabs, use over pourable underlayments, use with radiant heat, or use over concrete with excessive moisture vapor transmission and/or alkalinity. Membrane may also affect service rating.

Materials
• Multiple options exist for membranes, mortars, grouts, and other materials and MUST BE CLEARLY SPECIFIED to be included. If not specifically indicated, optional materials are not included and mortar/grout choice defaults to minimum performance specification indicated. Consider each system component and intended use to determine minimum requirements and to specify options.
• Ceramic tile—ANSI A137.1.
• Cementitious grout—ANSI A118.6 or better or ISO CG1 or better.
• Epoxy grout, when used—ANSI A118.3 or ISO RG.
• Cementitious mortar—as recommended by membrane manufacturer.
• Uncoupling membrane—recommended by manufacturer for use on young concrete; must achieve 50 psi or greater shear bond strength in 7 days per the test method in ANSI A118.12 Section 5.1.3.

Materials for Green/Sustainable Design
• See Green Building Standards and Green Product Selection Guide and consult manufacturers and suppliers for product sustainability and contribution to green building design.
• Consider specifying tile and installation materials that meet ANSI A138.1, the American National Standard Specifications for Sustainable Ceramic Tiles, Glass Tiles, and Tile Installation Materials.

Preparation by Other Trades
• Slab to have steel trowel and fine broom finish free of curing compounds. When used, mechanical scarifying is necessary.
• Maximum allowable variation in the installation substrate (concrete)—for tiles with all edges shorter than 15”; maximum allowable variation is 1/4” in 10’ from the required plane, with no more than 1/16” variation in 12” when measured from the high points in the surface. For tiles with at least one edge 15” in length, maximum allowable variation is 1/8” in 10’ from the required plane, with no more than 1/16” variation in 24” when measured from the high points in the surface.
• Slope, when required, to be in subfloor.

Movement Joint (architect must specify type of joint and show location and details on drawings)
• Movement joints—mandatory in accordance with EJ174.
Installation Specifications

- Tile—ANSI A108.5.
- Cementitious grout—ANSI A108.10.
- Epoxy grout—ANSI A108.6.
- Uncoupling membrane—follow manufacturer’s directions.
- Movement Joints—EJ171 and ASTM C1193.

Notes

- Keep traffic off finished tile floors until fully cured.
F147-16

- Joists 24" o.c./Plywood-Subfloor
- Plywood-Underlayment
- Uncoupling-Membrane
- Ceramic-Tile

Recommended Uses
- For wood substrates where joists are spaced 24" on center or less and water resistance and uncoupling are desired.

Service Rating
- Residential.

Environmental Exposure Classifications
- Res1, 2.
- May be suitable for increased water exposure when membrane manufacturer’s waterproofing instructions are followed. See Notes.
- For installations that may be exposed to staining, specify tile and grout suitable for exposure. Consult product manufacturers; see also Product Selection Guides.
- For installations that may be exposed to mild chemical attack, specify epoxy grout and tile suitable for exposure. Consult product manufacturers; see also Product Selection Guides.

Typical Weight of Tile Installation
- 7 pounds/square foot.
- Does not include weight of substrate. See Appendix B for assumptions, included materials, and their individual weights.

Limitations
- Maximum joist spacing 24" on center.
- 4" x 4" and larger tile only.

Requirements
- Plywood-underlayment—clean and free of dirt, dust, paint, and oily film.
- Specifier shall indicate if complete waterproofing is required, including if/how membrane connects to drain assembly, if base flashing is required, and treatment at other termination points.

Materials
- Multiple options exist for membranes, mortars, grouts, and other materials and MUST BE CLEARLY SPECIFIED to be included. If not specifically indicated, optional materials are not included and mortar/grout choice defaults to minimum performance specification indicated. Consider each system component and intended use to determine minimum requirements and to specify options.
- Ceramic tile—ANSI A137.1.
- Cementitious grout—ANSI A118.6 or better or ISO CG1 or better.
- Epoxy grout, when used—ANSI A118.3 or ISO RG.
- Uncoupling mortar—as recommended by membrane manufacturer.
- Uncoupling membrane—recommended by manufacturer; must achieve 50 psi or greater shear bond strength in 7 days per the test method in ANSI A118.12 Section 5.1.3.

Materials for Green/Sustainable Design
- See Green Building Standards and Green Product Selection Guide and consult manufacturers and suppliers for product sustainability and contribution to green building design.
- Consider specifying tile and installation materials that meet ANSI A138.1, the American National Standard Specifications for Sustainable Ceramic Tiles, Glass Tiles, and Tile Installation Materials.

Preparation by Other Trades
- 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. Maximum allowable floor member live load and concentrated load deflection shall not exceed l/360. See also Substrate Requirements.
- When concentrated loads (scissor lifts, pallet jacks, automobiles, forklifts, etc.) will be used on an above-ground tiled floor, the engineer and/or specifier shall specify a substrate to accommodate the concentrated loads. Owner/specifier is responsible for protecting the tilework from damage, including allowing sufficient time for installed materials to cure properly.
- Face grain of plywood subfloor and underlayment shall run perpendicular to joists.
- Trusses or I-joists with minimum 2-1/4" top flange (1-1/2" top flange permissible with 8" x 8" and larger tile); cross-bracing recommended.
- Subfloor—minimum 23/32" tongue and groove exterior glue-plywood with 1/8" gap between sheets.
• Underlayment—minimum 3/8" exterior glue plywood with 1/8" gap between sheets.

• Maximum allowable variation in the installation substrate (plywood underlayment)—for tiles with all edges shorter than 15", maximum allowable variation is 1/4" in 10' from the required plane, with no more than 1/16" variation in 12" when measured from the high points in the surface. For tiles with at least one edge 15" in length, maximum allowable variation is 1/8" in 10' from the required plane, with no more than 1/16" variation in 24" when measured from the high points in the surface.

• Vapor barrier on crawl space floors according to building code.

Movement Joint (architect must specify type of joint and show location and details on drawings)

• Movement joints—mandatory in accordance with EJ171.

Installation Specifications

• Tile—ANSI A108.5.

• Cementitious grout—ANSI A108.10.

• Epoxy grout—ANSI A108.6.

• Uncoupling membrane—manufacturer's directions.

• Movement Joints—EJ171 and ASTM C1193.

Notes

• Underlayment fasteners should not penetrate joists below.

• Seal seams between membrane sheets per membrane manufacturer's instructions to prevent moisture intrusion and protect adjacent walls and building materials. Base flashing should be used for maximum effectiveness.
**F148-16**

- Joists 19.2” o.c./Plywood Subfloor
- Uncoupling Membrane
- Ceramic Tile

**Recommended Uses**
- For wood substrates where joists are spaced 19.2” on center or less and water resistance and uncoupling are desired.

**Service Rating**
- Residential.

**Environmental Exposure Classifications**
- Res1, 2:
  - May be suitable for increased water exposure when membrane manufacturer’s waterproofing instructions are followed. See Notes.
  - For installations that may be exposed to staining, specify tile and grout suitable for exposure. Consult product manufacturers; see also Product Selection Guides.
  - For installations that may be exposed to mild chemical attack, specify epoxy grout and tile suitable for exposure. Consult product manufacturers; see also Product Selection Guides.

**Typical Weight of Tile Installation**
- 6 pounds/square foot.
  - Does not include weight of substrate. See Appendix B for assumptions, included materials, and their individual weights.

**Limitations**
- Maximum joist spacing 19.2” on center.
- 3” x 3” and larger tile only.

**Requirements**
- Plywood subfloor—clean and free of dirt, dust, paint, and oily film.
- Specifier shall indicate if complete waterproofing is required, including if/how membrane connects to drain assembly, if base flashing is required, and treatment at other termination points.

**Materials**
- Multiple options exist for membranes, mortars, grouts, and other materials and MUST BE CLEARLY SPECIFIED to be included. If not specifically indicated, optional materials are not included and mortar/grout choice defaults to minimum-performance specification indicated. Consider each system component and intended use to determine minimum requirements and to specify options.
  - Ceramic tile—ANSI A137.1.
  - Cementitious grout—ANSI A118.6 or better or ISO CG1 or better.
  - Epoxy grout, when used—ANSI A118.3 or ISO RG.
  - Cementitious mortar—as recommended by membrane manufacturer.
  - Uncoupling membrane—recommended by manufacturer; must achieve 50 psi or greater shear bond strength in 7 days per the test method in ANSI A118.12 Section 5.1.3.

**Materials for Green/Sustainable Design**
- See Green Building Standards and Green Product Selection Guide and consult manufacturers and suppliers for product sustainability and contribution to green building design.
- Consider specifying tile and installation materials that meet ANSI A138.1, the American National Standard Specifications for Sustainable Ceramic Tiles, Glass Tiles, and Tile Installation Materials.

**Preparation by Other Trades**
- 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. Maximum allowable floor member live load and concentrated load deflection shall not exceed 1/360. See also Substrate Requirements.
- When concentrated loads (scissor lifts, pallet jacks, automobiles, forklifts, etc.) will be used on an above-ground tiled floor, the engineer and/or specifier shall specify a substrate to accommodate the concentrated loads. Owner/specifier is responsible for protecting the tilework from damage, including allowing sufficient time for installed materials to cure properly.
- Face grain of plywood shall run perpendicular to joists.
- Subfloor—minimum 23/32” tongue and groove exterior glue plywood with 1/8” gap between sheets.
- Maximum allowable variation in the installation substrate (plywood underlayment) for tiles with all edges shorter than 15”; maximum allowable variation is 1/4” in 10’ from the required plane, with no more than 1/16” variation in 12” when measured from the high points in the surface. For tiles with at least one edge 15” in length, maximum allowable variation is 1/8” in 10’ from the required plane, with no more than 1/16” variation in 24” when measured from the high points in the surface.
Massage

• Vapor barrier on crawl space floors according to building code.

Movement Joint (architect must specify type of joint and show location and details on drawings)

• Movement joints—mandatory in accordance with EJ171.

Installation Specifications

• Tile—ANSI A108.5.
• Cementitious grout—ANSI A108.10.
• Epoxy grout—ANSI A108.6.
• Uncoupling membrane—manufacturer’s directions.
• Movement Joints—EJ171 and ASTM C1193.

Notes

• Seal seams between membrane sheets per membrane manufacturer’s instructions to prevent moisture intrusion and protect adjacent walls and building materials. Base flashing should be used for maximum effectiveness.
F180-16

- Joists 16" o.c./Plywood Subfloor
- Poured Gypsum Underlayment
- Bonded Membrane
- Ceramic Tile

**Recommended Uses**
- For wood substrates with a poured gypsum underlayment.

**Service Rating**
- Light commercial.
- When glass tile is used, service rating may be lower.

**Environmental Exposure Classifications**
- Res1; Com1.
- May be suitable for limited water exposure areas (Res2; Com2) with waterproof membrane. See Membrane Options.
- For installations that may be exposed to staining, specify tile and grout suitable for exposure. Consult product manufacturers; see also Product Selection Guides.
- For installations that may be exposed to mild chemical attack, specify epoxy grout and tile suitable for exposure. Consult product manufacturers; see also Product Selection Guides.

**Typical Weight of Tile Installation**
- 12 pounds/square foot with 3/4" poured gypsum. Add 2-1/4 pounds/square foot for each additional 1/4" of poured gypsum.
- Does not include weight of substrate. See Appendix B for assumptions, included materials, and their individual weights.

**Limitations**
- Maximum joist spacing 16" on center.

**Membrane Options**
- Requires use of crack isolation (A118.12) and/or waterproof (A118.10) and/or uncoupling membrane.
- Membrane must meet ANSI A118.10 for limited water exposure areas (Res2; Com2). Consult underlayment manufacturer for requirements.
- Specifier shall indicate if complete waterproofing is required, including if/how membrane connects to drain assembly, if base flashing is required, and treatment at other termination points.
- Check with membrane manufacturers for suitability for applicable conditions, as not all membranes are suitable for steam, high temperature, and/or chemical exposure, exterior use, use over above-ground structural slabs, use over pourable underlayments, use with radiant heat, or use over concrete with excessive moisture vapor transmission and/or alkalinity. Membrane may also affect service rating.
- When glass tile is used, consult glass tile manufacturer for membrane options and recommendations.

**Requirements**
- Proper curing/drying of underlayments prior to application of tile is critical for proper performance. Consult the underlayment manufacturer for specific instructions.

**Materials**
- Multiple options exist for membranes, mortars, grouts, and other materials and MUST BE CLEARLY SPECIFIED to be included. If not specifically indicated, optional materials are not included and mortar/grout choice defaults to minimum performance specification indicated. Consider each system component and intended use to determine minimum requirements and to specify options.
  - Ceramic tile—ANSI A137.1.
  - Glass tile, when used—ANSI A137.2; see also Glass Tile Selection and Installation Guide, and consult tile manufacturer for service rating and environmental exposure classification recommendations. Not all glass tiles are suitable.
  - Cementitious grout—ANSI A118.6 or better or ISO CG1 or better. When glass tile is used, specify grout designated by tile and grout manufacturers.
  - Epoxy grout, when used—ANSI A118.3 or ISO RG.
• Cementitious bond coat:
  • When a crack isolation membrane is used—ANSI A118.4 or better or ISO C2S1 or better.
  • When a waterproof membrane is used—ANSI A118.4 or better or ISO C2S1 or better unless ANSI A118.1 or ISO C1 is recommended by membrane manufacturer.
  • When an uncoupling membrane is used, check with membrane manufacturer.
  • When glass tile is used, specify mortar designated by tile and mortar manufacturers. For translucent glass, use white mortar.
  • Crack isolation membrane, when used—ANSI A118.12.
  • Waterproof membrane, when used—ANSI A118.10.
  • Uncoupling membrane, when used—recommended by uncoupling membrane manufacturer; must achieve 50 psi or greater shear bond strength in 7 days per the test method in ANSI A118.12 Section 5.1.3.

**Materials for Green/Sustainable Design**

• See Green Building Standards and Green Product Selection Guide and consult manufacturers and suppliers for product sustainability and contribution to green building design.

• Consider specifying tile and installation materials that meet ANSI A138.1, the American National Standard Specifications for Sustainable Ceramic Tiles, Glass Tiles, and Tile Installation Materials.

**Preparation by Other Trades**

• 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. Maximum allowable floor member live load and concentrated load deflection shall not exceed l/360. See also Substrate Requirements.

• When concentrated loads (scissor lifts, pallet jacks, automobiles, forklifts, etc.) will be used on an above-ground tiled floor, the engineer and/or specifier shall specify a substrate to accommodate the concentrated loads. Owner/specifier is responsible for protecting the tilework from damage, including allowing sufficient time for installed materials to cure properly.

• Poured gypsum underlayment—minimum compressive strength of 2000 psi when tested per ASTM C472 modified and meeting performance requirements of ASTM C627 for the anticipated service level designated by the specifier or intended use.

• Poured gypsum underlayment thickness and application varies, consult the manufacturer for specific recommendations.

• Maximum allowable variation in the tile substrate—for tiles with all edges shorter than 15", maximum allowable variation is 1/4" in 10' from the required plane, with no more than 1/16" variation in 12" when measured from the high points in the surface. For tiles with at least one edge 15" in length, maximum allowable variation is 1/8" in 10' from the required plane, with no more than 1/16" variation in 24" when measured from the high points in the surface.

• Face grain of plywood shall run perpendicular to joists.

• Exterior grade plywood subfloor to be clean and free of dirt, dust, paint, and oily film.

• Some manufacturers of poured gypsum underlayments require use of plastic lath. Follow manufacturer’s recommendations for installation and use of the lath.

• Surfaces must be prepared and primed according to the underlayment manufacturer’s instructions.

• Subfloor—minimum 23/32" tongue and groove exterior glue plywood.

• Poured gypsum underlayment—installed only by a manufacturer-approved applicator in accordance with manufacturer’s recommendations.

**Movement Joint (architect must specify type of joint and show location and details on drawings)**

• Movement joints—mandatory in accordance with EJ171.

• When glass tile is used, adhere to more frequent placement recommendations within the ranges listed in EJ171.

**Installation Specifications**

• Tile—ANSI A108.5.

• Glass tile—manufacturer’s directions.

• Cementitious grout—ANSI A108.10.

• Epoxy grout—ANSI A108.6.

• Crack isolation membrane—ANSI A108.17.


• Uncoupling membrane—manufacturer’s directions.

• Movement Joints—EJ171 and ASTM C1193.

**Notes**

• Some manufacturers require special primers prior to the application of the membrane. Follow manufacturer's directions.

• When glass tile is used, see Glass Tile Selection and Installation Guide, and consult manufacturer for recommendations and requirements.
the tolerance is expressed as an allowable gap, e.g., 1/4” in 10’. This method evaluates each place of measurement individually.

Because an \( F_c \) value is derived from many measurements, concrete that meets a specified \( F_c \) of 35 will typically have areas that do not meet the required flatness tolerance to receive tile. This is particularly true when larger tiles will be installed because of the tighter tolerance that applies—the maximum allowable variation for any areas where tiles with at least one edge 15” in length or longer will be installed is 1/8” in 10’ from the required plane, with no more than 1/16” variation in 24” when measured from the high points in the surface. For tiles with all edges shorter than 15,” the maximum allowable variation is 1/4” in 10’ with no more than 1/16” variation in 12.” If these tolerances are not met, the tile contractor cannot provide an installation that complies with tile industry tolerances for flatness and lippage.

In addition to the lack of correlation between the two methods, there are other provisions of the ASTM E1155 method that are problematic in consideration of the flatness requirements for tile. The method requires measurements be taken within 72 hours of concrete placement, before concrete curling and shrinkage resulting from the curing process has culminated. While the concrete may meet the tolerance at the time of measurement, the flatness can change significantly afterward, generally becoming less flat, not more. Additionally, no measurements are taken at construction, isolation, or control joints, at column block-outs, or within 2 feet of the perimeter of the slab; these are typically the areas with the greatest amount of variation due to curling.

For a concrete substrate that is suitably flat to receive tile, provide a bid allowance for any necessary floor preparation needed to bring the floor into tolerance for tile. Providing such an allowance facilitates bid comparison on an equal basis and helps avoid change orders. Unless subfloor preparation is specifically required by the specification, or a bid allowance is included, the tile contractor assumes a suitably flat subfloor will be provided. Industry standards for tile finish flatness and lippage do not apply if the project owner does not provide a substrate that meets required flatness tolerances for tile or authorize the tile contractor to correct substrate flatness issues. See also: Subsurface Tolerances and Large Tile.

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**Maximum Allowable Deflection for Framed Walls**

The maximum allowable deflection for framed walls to receive tile is \( l/360 \).