

# INSTALLATION CHALLENGES AND SOLUTIONS: EXTERIOR TILE AND NATURAL STONE FAÇADES



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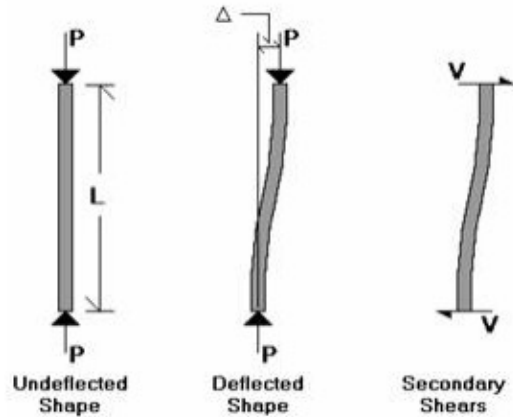
A QUIKRETE<sup>®</sup> COMPANY

Note: The recommendations within this document are common industry standards and Custom Building Products' requirements. Additional limitations or specific recommendations may be listed within the Technical Data Sheets of products used in an installation assembly. When those instructions conflict with this document, the most stringent requirements and limitations shall apply.

Using tile or natural stone as a building's veneer creates an elegant aesthetic appearance and is among the most long lasting and lowest maintenance choices as well. But to specify and install a trouble-free assembly, design considerations must address the wide variety of climatic and structural stresses that will occur. Product components of the façade assembly must perform in the project's environment; and the installation process needs to be well-defined and in strict adherence to industry and manufacturer's requirements. Please consider some of the installation challenges and solutions below.

## Installation Challenges

**In Design:** A tile façade installation must have a sound, stable and suitable structural backing and concrete / masonry surfaces are required for direct bonding. Concrete surfaces whether cast-in-place, tilt-wall or other must be free from form releases or curing compounds that may interfere with adhesion. Regarding stability, ACI 530 states an out of plane deflection limit of  $0.007 * h$  which must include p-delta effects for walls (as shown).



The P-Delta Effect

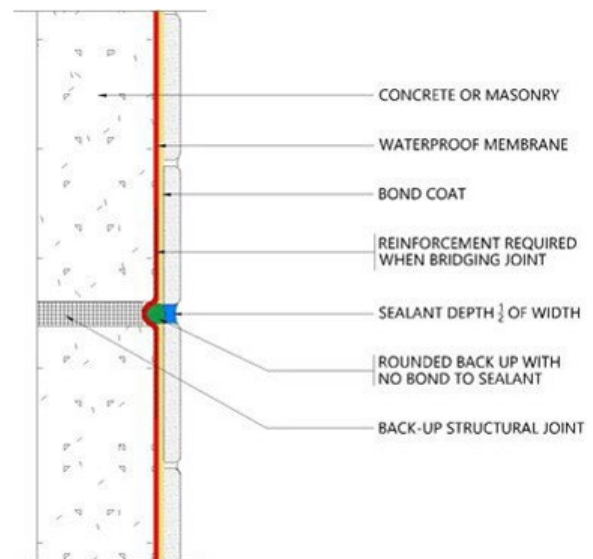
**Deflection:** Not all standards for deflection ratings are aligned. For example, the deflection rating from the **International Building Code** states that out of plane deflection for walls should be **no more than L/240** for brittle finishes. In contrast, **the tile industry recommends no more than L/360**. According to the Natural Stone Institute, walls and partitions constructed of metal studs should be designed for a maximum deflection of **no more than L/720 for natural stone**. Framing, sheathing and/or lath installation must meet deflection ratings and resist excessive deflection or sagging for the life of the project.

**The lack of adequate movement joints is one of the most common causes of façade failures.**

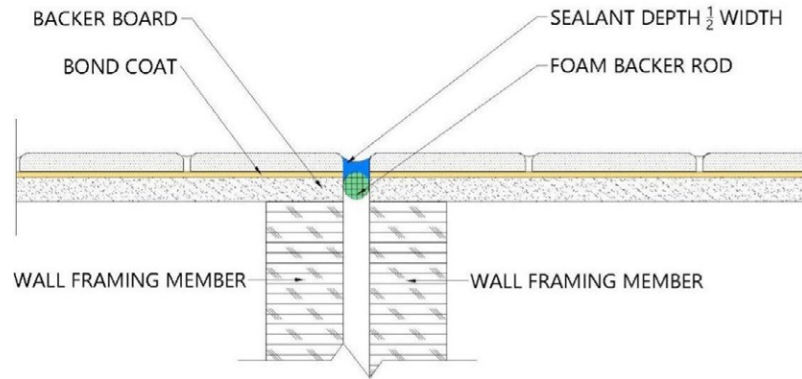
Joints in concrete walls that are designed to move must have corresponding joints in the tile assembly. (Example shown based on - TCNA EJ-ECW) steel or wood framing must also be designed in line with cement backerboard manufacturer's recommendations and industry requirements for lath applications. (Example shown based on — TCNA EJ 171K). Additionally, movement joints are to be placed at proper intervals, widths, and locations in the tile pattern to accommodate thermal growth.

**TCNA EJ 171** recommends - minimum 3/8" wide on joints 8' on center and minimum 1/2" wide on joints 12' on center; add 1/16" for every 150°F over a winter/summer variation of 100°F.

**TTMAC** recommends 10 mm from 2400 mm to 3600 mm in each direction; in extreme temperature variations, 40°C between summer/winter, 13 mm in each direction.

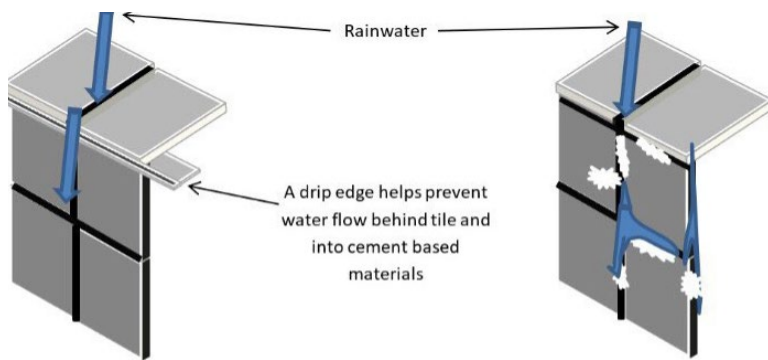


CEJ 171 ECW Expansion Joint -  
Concrete or Masonry Walls

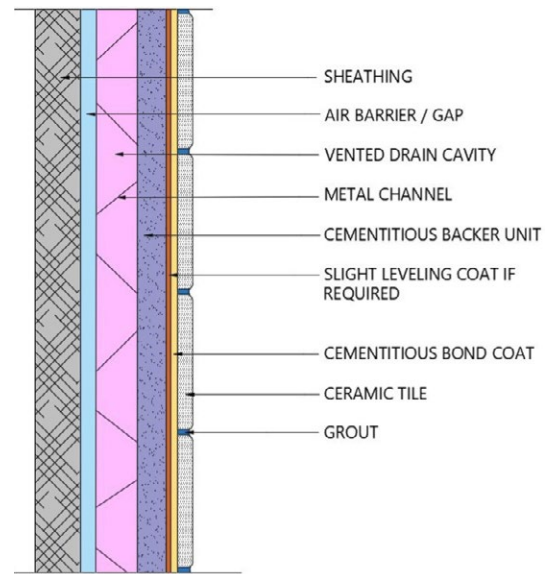


*CEJ 171K Movement Joint in Tile and Backerboard*

Water evacuation and moisture vapor management must also be designed to accommodate climatic conditions. Appropriate flashing and roofing details such as drip edges must direct water to the finished surface of the tile and not behind it or efflorescence can occur; weep routes must be incorporated at appropriate locations. Vented drain cavities may be required to accommodate moisture vapor. (Vented Drain Cavity Detail based on TTMAC 305W).



*Drip Edge - Reducing Efflorescence*



*Vented Drain Cavity*

**Substrate Surface:** Aside from requiring the surface to be absorptive and free of contaminants, the profile of a surface for direct bonding is to be the ICRI CSP 2 or greater per the ICRI Technical Guideline No 310-2. Tolerances for concrete walls, CMU (Concrete masonry Units, CBU (Cement backerboard units) and plaster coats vary considerably for flatness and plumb requirements. Generally, 1/4" in 10' (6 mm in 3000 mm) flatness is the anticipated result for flat-backed dimension tile and natural stone installation but for formats  $\geq 15"$  (380mm) on any side, the requirement is 1/8" in 10" (3 mm in 3000 mm) so additional preparation is likely to be required. Not only does the greater flatness contribute to a more aesthetically pleasing installation, this starting point for using mortar reduces the error of using adhesive mortars to unacceptable thicknesses and spot-bonding.

**Materials:** Manufactured tile or dimension stone specified for an exterior façade must be suitable for the project's environmental conditions. Some questions to consider are: Is the tile or stone suitable for freeze/thaw conditions or will these cycles break them down? Is it UV resistant? What is its solar reflectance and anticipated thermal growth? What is its absorption rate as tiles with low absorption fare better in exterior applications? There are restrictions on tile sizes and weights as shown below:

- **Natural stone units:** allowed up to 1/2" (13 mm) thicknesses are limited to 36" (914 mm) in the largest dimension and not more than 720 square inches (0.46 m<sup>2</sup>) in total area for direct adhered applications. By weight, the limitation is 15 pounds per square foot (73 kg/m<sup>2</sup>) unless approved by local officials and the design team.
- **Gauged porcelain tile and porcelain tile / slabs (GPTP):** 1/8" (3 mm) to 1/4" (6 mm) thick – 17.5 sf per unit maximum facial dimension / 3.5 lbs. per sf maximum weight Maximum dimension on a side = 72" - (example of allowable sizes = 35" x 72")
- **Standard thickness porcelain tile finishes:** 1/4" (6 mm) to 5/8" (15 mm) thick – 9 sf per unit maximum facial dimension / 6 lbs. per sf maximum weight Maximum dimension on a side = 48" – (example of allowable sizes = 24" x 48", 36" x 36")

Suitable backing and sheathing materials must be used within the assembly according to industry standards and manufacturer's instructions. Cement backer units (CBU) and sheathing have various Environmental Exposure Ratings as described in the (TCNA) Tile Council of North America's Handbook and products must accommodate Com6 or Res6 ratings for exterior conditions.

**Note:** Gypsum-cored sheathing is acceptable for many exterior finishes but is not recommended as a substrate for direct bonding of tile or natural stone either by their manufacturers or by installation material manufacturers.



*Gypsum-Cored Sheathing*

Mortar bed renders, plasters and stucco can be suitable surfaces but require curing time frames as set by manufacturers to dissipate moisture and gain sufficient strengths. When recommendations are not available, allow these materials to achieve moisture levels ≤5% measured with a concrete moisture meter meeting ASTM F2659 prior to applying membranes or adhesive mortars. These applications must also have movement joints to help avoid shrinkage cracking and accommodate structural movement and expected thermal growth. Cleavage membranes must meet ANSI A108.M-2.8.1. Lath must be galvanized and meet ASTM C847.



*Concrete Moisture Meter*

Liquid-applied air-barriers and waterproofing membranes must meet ANSI A118.10 requirements and be recommended by the manufacturer for exterior façades to direct bond tile or natural stone. Crack isolation membranes should meet ANSI A118.12 – High Performance to assist with thermal expansion. Reinforcing fabric for waterproofing membranes is typically required at seams and joints with special instructions to accommodate structural movement. Note: Liquid membranes typically have a limited time frame ≤3 days for UV exposure before bond strengths are reduced, therefore tiles must be installed within this period.



*Liquid-Applied Waterproofing and Crack Isolation Membrane*

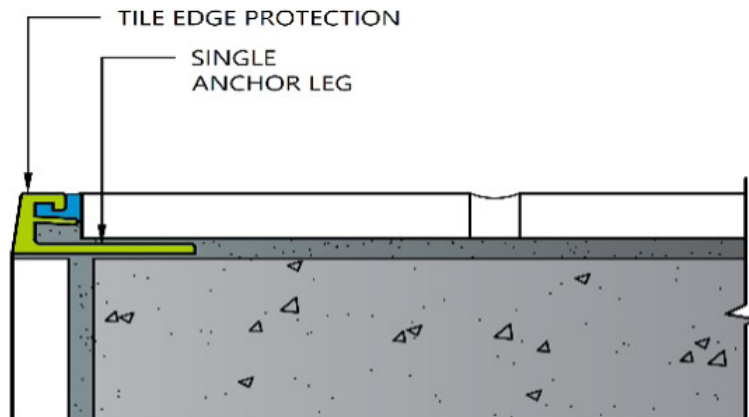
Regarding adhesive mortars, TCNA lists ANSI A118.4 or A118.15 classifications as acceptable mortars with  $\geq 200$ psi &  $\geq 400$  psi shear bond strengths respectively to bond porcelain tiles and natural stone. While this is the case, most manufacturers recommend A118.15 improved mortars for their higher bonding performance and higher polymer levels for deformation characteristics to assist with thermal growth. Rapid-setting mortars should also be considered as they reduce the potential for efflorescence and assist with faster resistance to detrimental effects of rainfall and freeze/thaw in early stages of the installation. As shown, efflorescence removal can be costly with the potential for recurrence.

Your grout choice also matters! ANSI A118.7 cement grouts are less absorptive and less susceptible to stains. Many are also rapid setting and formulated with calcium aluminate cement not only cure faster with more consistent color but can help reduce or eliminate efflorescence. When applying grouts to textured Porcelain or natural stone, a sealer or grout release may be useful to avoid grout staining/hazing.



*Removing Efflorescence*

Sealant for movement joints must meet ASTM C920 Class 25 requirements. When installing natural stone, ensure that the sealant is rated NS (non-staining) and conforms to **ASTM C1248**. **Appropriate backer rod should be specified along with the sealant**. When using manufactured joint profiles either in conjunction with sealant or alone, allow space at the profile for movement or use profiles designed to accommodate expansion (as shown).



*Movement Joint Profile*

## Installation

Who installs the tile assembly is as important as how it's designed! Due to the potential liability costs and safety requirements for a tiled façade, the low bidder may not be the best option in the long run.

**Note:** typical specification verbiage for these applications regarding companies employing properly trained laborers; the need for a mock-up; and sufficient communication for a successful project:

- A. Installer Qualifications: Company specializing in performing the work of this section with a minimum of five years documented experience.
  - 1. The installer shall be a five-star member of the National Tile Contractors Association or a Trowel of Excellence member of the Tile Contractors' Association of America.
  - 2. Installers on-site supervisor shall hold the International Masonry Institute's Foreman Certification.
  - 3. Installer shall employ Ceramic Tile Education Foundation Certified Installers or installers recognized by the U.S. Department of Labor as Journeyman Tile Layers.
  
- B. Mock-Up: Provide a mock-up for evaluation of surface preparation techniques and application workmanship.
  - 1. Locate mock-ups on site in locations and size directed by Architect.
  - 2. Finish areas designated by Architect.
  - 3. Do not proceed with remaining work until workmanship, color, and sheen are approved by the Architect/Design Team.
  - 4. Refinish mock-up area as required to produce acceptable work.
  - 5. Retain and maintain mock-ups during construction in undisturbed condition as a standard for judging completed unit of Work.
  - 6. Obtain Architect's acceptance of mock-ups before start of final unit of Work.
  
- C. Conduct conference at Project site to comply with requirements of Division 1 Section "Project Meetings."

**Critical Differences in Installation Techniques – Tile Contractors vs. Masons:** Tile contractors use mortar installation methods defined by ANSI A108. Masonry contractors use installation methods defined by the Masonry Veneer Manufacturers Association's (MVMA's) Installation Guide and Detailing Options for Compliance with ASTM C1780 for Adhered Manufactured Stone Veneer National Concrete Masonry Association's (NCMA's) TEK 20-1 (2014), Key Installation Checkpoints for Manufactured Stone Veneer. Porcelain and other tile manufacturers recommend ANSI installation methods and products. Thin brick, ledger and other stone manufacturers refer to the masonry industry's recommended methods and products or will leave the decision to the specifier. In these circumstances, miscommunication has led to installation failures so Instructions must be clearly called out. Note the following actual occurrences:

Contractors conscientiously referred to thin brick or stone product instructions and have been directed to a different and incorrect method from the project specification. This led to substantial failures.

Installers who haven't read the product instructions or haven't referred to the project specification, defaulted to the methods they normally use. Their methods were not compatible with the specified installation products or assembly components.

As shown below, the mortar application method used by masons involves applying Type S Mortar to the tile underside and then pressing the tile onto a rough masonry surface, a cured application of referred to as a scratch coat. The mortar primarily achieves a mechanical bond.



The ANSI A108.5 mortar installation method for large tiles and natural stone (shown below) includes flat-back troweling the underside, troweling adhesive mortar on the substrate in straight rows and fully collapsing the ridges to achieve  $\geq 95\%$  coverage. **Spot bonding is not an acceptable method using ANSI classified mortars.** For this method, the substrate must be flat, plumb, and true within ANSI requirements. ANSI classified products used in this method achieves a mechanical and chemical bond. A chemical bond is essential to adhere tile to membranes. See the National Tile Contractors Association video — [Trowel & Error](#) for additional information. **Note:** Refer to ANSI A108.20 for special installation methods for exterior Gauged Porcelain Tile Panels.



*Spot-Bonding — Not an acceptable practice for ceramic, thin brick or dimension stone tile using ANSI A108 methods.*

## Solutions

**Design:** There are numerous assembly details that have been proven successful for exterior façade installations. The Tile Council of America's Handbook contains W201, W202, W211, W221, W222, W 231, W241. The Tile, Terrazzo and Marble Association of Canada's Specification Guide lists 302W, 303W 305W/A, 307W, 308W/B & 310W. The Installation Guide and Detailing Options for Compliance with ASTM C1780 contains numerous details as well. These publications suggest the minimum requirements and options for the assemblies. Note that each detail references the requirement for adequate movement joints. Joint widths and frequencies (in addition to structural joint locations) are determined by the finish products' thermal expansion rates and project location temperatures anticipated on a yearly basis. Calculations for movement joints should be based on the worst case heat and humidity conditions. Typically, south- and west-facing sides of a structure experience higher temperatures with upper floors on these sides, the most extremes. Temperature cycling from hot to cool such as in a southwest desert climate dictate that joint widths and frequency of placement should incorporate a larger allowance over the minimum recommendations

**Products:** Custom Building Products recommends that the products specified for the installation are to be only high-performance rated due to the typical harsh conditions that will be experienced over the life of the project. (See list of recommended products in table on pg. 6) While products and methods used in the masonry industry and tile industry are both acceptable depending on the substrate type and products specified in the assembly, the ANSI A118.15 rated mortars typically can provide substantially stronger bonds and A108 methods of applying mortar achieve greater mortar coverage without voids for water intrusion and subsequent thermal growth stresses. The method of applying adhesive mortars should be clarified in the specification:

- Install tile in accordance with appropriate ANSI A108 specifications and installation product manufacturer's directions.

**Substrate Surface:** All surfaces to accept installation products such as liquid membranes and adhesive mortars must be free of bond-inhibiting materials such as form release and curing agents. Porosity is required for adhesion. Flatness tolerances are described previously. The use of manufacturer approved products must be used for preparation when required.

**Efflorescence:** Efflorescence of minerals in cement-based materials – concrete, mortar beds, plaster/stucco, adhesive mortars, and grouts can create substantial maintenance costs, therefore consider membranes and specialty products that lessen or eliminate these occurrences. Some natural stones and cement-based tiles can be dimensionally unstable or moisture sensitive and may warp. They may also contain minerals that create a "rust effect". Request information from suppliers. Also, consider a six-sided sealer application with a penetrating sealer.

**Movement Joints:** Per ANSI A108.01 – 2.1.5.2, it is the responsibility of the design professional to locate and detail movement joints. According to ANSI A108.02, it is the responsibility of the tile/sealant installation contractor to assure that the space below the sealant is free of mortar or grout. A compressible backup material such as closed cell backer rod is to be used to allow the sealant to compress and expand freely. As the proper placement of movement joints is very critical for a successful project, any clarifications on joint placement should be confirmed prior to installation.

**Climatic Conditions:** Generally, cement-based products require surface, ambient and mixing water temperatures to be at least  $\geq 50^{\circ}\text{F}$  ( $10^{\circ}\text{C}$ ) during application and during curing time frames (typically for a period of seven days after application). High heat  $\geq 90^{\circ}\text{F}$  ( $32^{\circ}\text{C}$ ), direct or extended sunlight or windy conditions can also adversely affect installation products causing them to dry too quickly without achieving adequate strengths. Refer to UV exposure limits of membranes as exposure  $>3$  days may be detrimental for bonding. Heating or tenting may be required to provide proper working conditions; chilling or warming water may also be required.

## Product Selection

√ *Products to specify that reduce or not contribute to efflorescence.*

*Include a membrane along with products marked below:*

CUSTOM® products have been successfully used in specifications for millions of tiles and have lasted for decades. CUSTOM Limited Installation System Warranties are available for assemblies using these products covering labor and material replacement. Please consider these options for your project:

### Crack Isolation and/or Waterproofing (Primary or secondary membrane)

√ [RedGard® Crack Prevention and Waterproofing Membrane](#)

### Adhesive Mortars

√ [MegaLite® RS Ultimate Rapid Setting Crack Prevention Large Format Mortar](#) (650-725 psi bond strength to porcelain tile)

√ [ProLite® RS Premium Rapid Setting Large Format Tile Mortar](#) (400-500 psi bond strength to porcelain tile)

[MegaLite® Ultimate Crack Prevention Large Format Tile Mortar](#) (650-725 psi bond strength to porcelain tile)

[ProLite® Premium Large Format Tile Mortar](#) (400-500 psi bond strength to porcelain tile)

**Mortar Bed** (Will not contribute to efflorescence when encapsulated by CUSTOM Waterproofing Membrane)

√ [Thick Bed Bedding Mortar](#) gauged with Thin-Set & Mortar Admix

### Grout

√ [Prism® Ultimate Performance Cement Grout](#)

### Sealant

√ [CUSTOM® Commercial 100% Silicone Sealant](#)

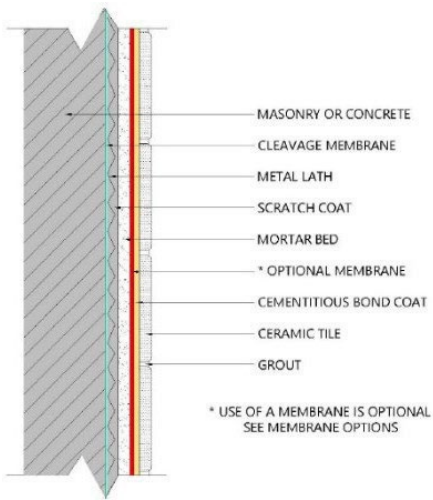
### Sealers

√ [Aqua Mix® Sealer's Choice® Gold – Rapid Cure Formula](#)

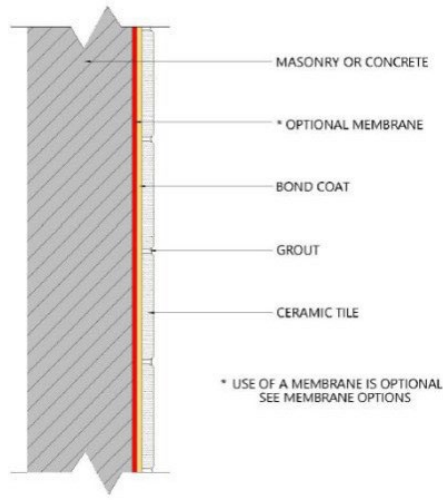
√ [Aqua Mix® Penetrating Sealer](#)

**Note:** Project conditions will vary and may affect product recommendations. Consult individual product Technical Data Sheets for specific recommendations and limitations regarding project conditions. Assembly mock-ups can determine suitability for these conditions on specific projects. For project specification review, on-site technical assistance, product, specification and warranty details contact CUSTOM Architectural Services, Technical Support at (800) 282-8786 or [Custom Building Products – Contact Us](#).

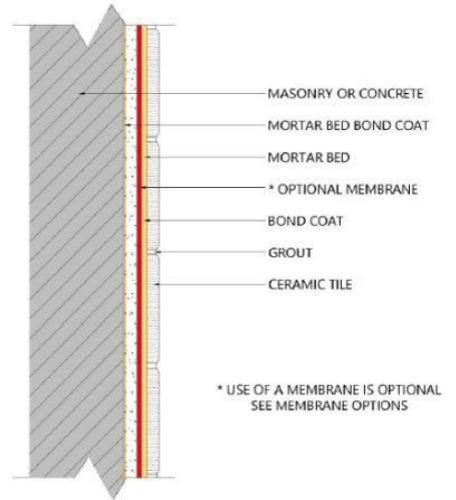
**Suggested Assemblies:** See industry recognized details below:



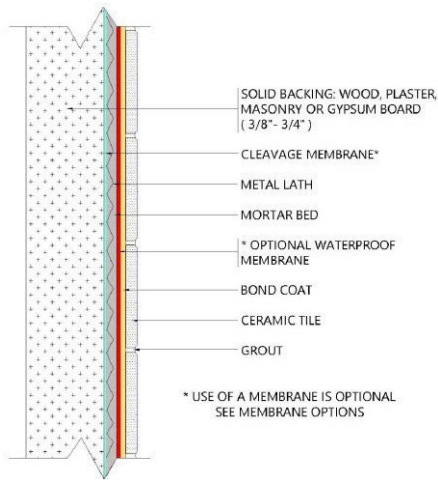
**W201/307W Masonry  
 or Concrete Mortar Bed**



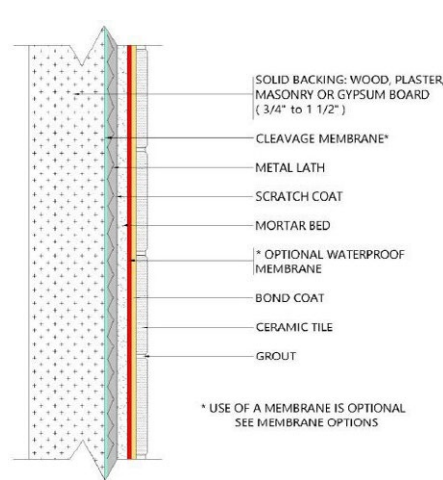
**W202/303W Masonry  
 or Concrete Mortar Bed**



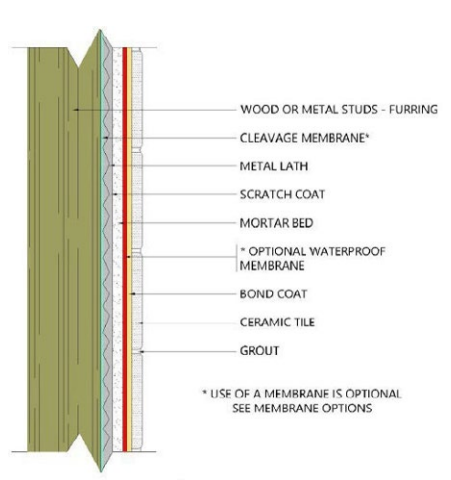
**W211/302W Masonry  
 or Concrete Bonded Mortar Bed**



**W221/307W Solid Backing  
 Bonded Mortar Bed**



**W222 Masonry  
 or Concrete**



**W231/241 308W Wood  
 or Metal Studs**

**Note:** Assembly details shown above may be used for interior and exterior applications.  
 Refer to TCNA/TTMAC Handbook for exterior specification requirements.

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