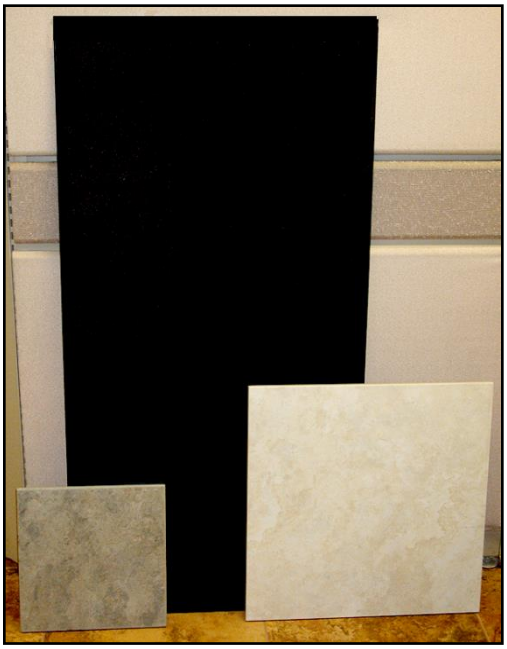
ACT
ADVANCED CERTIFICATIONS FOR TILE INSTALLERS
LARGE FORMAT TILE

Large Format Tile & Substrate Preparation Study Guide

Overview



Ceramic tile has been around for thousands of years and is known as one of the most durable building materials man has ever developed. Since about 1975, it seems there has been an explosion of technological developments in ceramic tile from the materials that go into its composition to the way the material is manufactured. In 1975, the only tiles readily available in the United States were the standard 4 ¼" x 4 ¼" wall tile; 1" x 1" and 2" x 2" ceramic mosaics; and 4" x 8" and 6" x 6" quarry tile. Today, with these technological advancements, tile dimensions have changed dramatically. A tile 2' x 2' is not extraordinary. The durability of these products is truly amazing and the colors and patterns can convincingly mimic anything from wood to stone. As these developments in ceramic tile have taken place, the architectural and design community as well as the general public have become aware of the beauty and durability of these new tiles. The demand for larger and larger format ceramic tile has been one of the fastest growing segments in the building industry. One of the challenges facing our industry is how to ensure the proper installation and life-cycle performance that will not negatively impact the industry with failures. The bigger the tile gets, the more challenging the installation requirements are to meet. It requires us to rethink how we placed tile in the past, modifying our methods to provide a flatter surface than previously required—specialized bonding mortars, mechanical edge leveling system, and qualified installers equipped with the skills to handle large format tiles.

4" x 16" tiles are large format

This study guide is designed to give the experienced installer insight into the knowledge required for the installation of large format tiles. This knowledge will have a big impact on the success of the installation as well as the installer. The first step for developing the knowledge required to install large format tile is to review the definition. Although it has not received a

specific definition in either the TCNA *Handbook* or ANSI Specifications, they

are generally considered to be tiles that have at least one side dimension of 15 inches or greater. However, the tile does not have to be 15 inches on each side. It could be a 4" x 15" tile and still considered a large format tile.

This study guide will only be addressing tiles that are more than ¼" (6 mm) in thickness. Tiles ¼" (6 mm) and less are considered "reduced thickness or thin tiles" and require a totally different set of specialty installation requirements.

Since ANSI specifications require a minimum of 80% coverage for interior dry installations or 95% coverage for exterior or shower installations a proven method must be used to obtain the required coverage.

ACT testing time at the site: Setup, installation and cleanup. Time allowed: 4 hours. Testing materials will be provided.

Substrate Preparation

When dealing with "large format tiles" also known as LFT, one of the most important steps to installing the tile is to prepare the substrate properly. It stands to reason that the flatter the substrate, the easier it will be to achieve the proper coverage and minimal lippage. The tiles themselves may have variations in thickness and warpage which makes the installation more difficult when compounded by variations in the substrate.

Be certain to review ANSI A108.01.2.6.2.2 for further information.

This ANSI standard shows that there are different tolerances for large format tiles. It is important for the architect and general contractor to know what the finishing materials will be because it does affect the tolerances that the concrete contractor must try to meet. Normally, the concrete contractor is not required to achieve any closer tolerances than the ¼" in 10 feet. It is usually the ceramic tile contractor that must bring the substrate to within 1/8" in 10 ft. tolerance. In some instances, the floor can be recessed to receive a mud bed that can be installed by the tile contractor.

Trowel applied (flash) patch being applied

For minor variations in the substrate, cementitious floor patching materials can be effective in bringing the substrate to tolerance. This may be accomplished by using a self-leveling underlayment (SLU) or a trowel applied (flash) patch, as shown here, to provide the smooth flat surface required. Whichever method is used, be certain the floor is flat to the desired tolerance before any

tile is installed.

As large format tiles have developed, new setting materials have also been developed to help the installer achieve the proper coverage. Sometimes, the warpage in these tiles requires setting material thickness to be in excess of what thin-set materials are designed to handle. If applied in excess of ¼ in. thickness, thin-set materials can develop shrinkage cracking and can even cause the tile to lose bond. Industry manufacturers have developed Medium Bed Mortars to fill the need for a mortar that can be applied in excess of ¼ in. Please review the statement of Medium Bed Mortar found in the "Setting Material Selection Guide" of the TCNA *Handbook.*

Currently there is no ANSI specification or definition for medium bed mortars but, the development of an ANSI specification for Medium Bed Mortars is in process based on the statement found in the "Setting Material Selection Guide" in the *TCNA Handbook*. Also please note that medium bed mortar is a product, not a method of installation.

One common misunderstanding in the industry is that the installation of large format tile requires the use of a medium bed mortar. This may not be necessarily true. If a very flat tile and a very flat substrate are utilized, adequate coverage may be achieved with a final setting material thickness of 3/16"or less. This could be accomplished with a setting material that does not have medium bed capabilities (conventional thin-set mortar) and could possibly be less expensive.

The tile contractor will need to address these substrate plane variations and provide correction by some method. If the tile contractor and the general contractor determine that the substrate is out of tolerance, the tile contractor may be able to acquire a change order to address these variations with patching material and be compensated for the materials and the labor to install it.

Floor Flatness

Though experienced tile contractors are accustomed to measuring substrate irregularities with a 10 foot straight edge, there is another method becoming very popular with general contractors of which tile contractors should be aware. The method measures floor flatness (FF) and floor levelness (FL). These measurements are taken electronically with a laser apparatus and determine an <u>average</u> floor flatness number. The measurements are normally taken within three days of the concrete being poured and are used to determine if the concrete contractor has accomplished a successful pour and finishing operation. The reason the tile contractor should be familiar with these FF measurements is the general contractor may object to providing extra compensation for tolerance corrections based on these FF numbers. The problem with this reasoning is the concrete substrate goes through substantial changes after these

numbers are established. The concrete mixture, rebar reinforcement and curing methods can all have a great deal of influence on the amount of shrinkage, creep, contraction and curling that occurs after these FF numbers have been established. If FF numbers are going to be used to determine if a substrate is within the required tolerances for a large format tile installation, the FF numbers should be determined just prior to the tile installation.

Approximate Correlation Equivalence between FF-Numbers and Traditional 10 ft. Straightedge			
	Grout Joint Size		
Tile Size	1/4" or larger	3/16"	1/8"
+/- 1/2"	Minimum Subfloor Flatness per ASTM E1155-06, ACI-117-06 and ANSI-108.1B-99		
8" x 8"	FF25 or 1/4" -10'	FF32 or 3/16" - 10'	FF50 or 1/8" - 10'
12" x 12"	FF25 or 1/4" -10'	FF32 or 3/16" - 10'	FF50 or 1/8" - 10'
16" x 16"	FF25 or 1/4" -10'	FF32 or 3/16" - 10'	FF50 or 1/8" - 10'
18" x 18"	FF32 or 3/16" - 10'	FF50 or 1/8" - 10'	FF60 or 3/32" - 10'
24" x 24"	FF32 or 3/16" - 10'	FF50 or 1/8" - 10'	FF60 or 3/32" - 10'
36" x 36"	FF50 or 1/8" - 10'	FF60 or 3/32" - 10'	FF60 or 3/32" - 10'

NTCA Reference Manual Floor Flatness (FF) Chart

These same tolerances for floor flatness are required for wood substrates. There are additional requirements for wood substrates that are addressed in ANSI A108.01.3.4 and in the TCNA *Handbook* in the “Substrate Requirements” section.

Large format tiles can bridge multiple floor joists with one tile. This can present the problem of “differential deflection” in some cases. Differential deflection can occur when you have one floor joist supported from below (*such as over a parallel wall in the basement*) and other adjacent joists not supported in the same area. There is a difference in the deflection from one joist to the other with the same load that can cause the tile to torque and crack or possibly lose bond. In some instances, blocking between joists could be required to produce a successful installation.

Substrate Suitability

Once it has been determined whether or not the substrate is within tolerance, the next step is to make sure the substrate will accept a bond with the materials specified to accomplish the installation. There is a saying in the tile industry. “Your bond is only as good as the surface to which you are bonding.” It is very common to encounter concrete substrates that have had curing compounds applied in areas to receive ceramic tile even though it is against ANSI Specifications to do so. Curing compounds are not designed to have a tenacious bond to the concrete. They are merely to function as a coating which locks moisture in the concrete to assist in the curing process. After the concrete has reached its designed strength, these products are no longer needed

and, in some cases, will start to break down and be removed from the concrete surface from construction traffic.

Concrete substrates must be tested in many non traffic areas to make sure the surface is porous enough to allow the absorption of water. A water droplet should be absorbed by and darken the concrete within 15 seconds. If it does, the porosity is sufficient to achieve a good bond. If not, it probably means a curing compound or some other contaminant is still present and must be mechanically abraded by shot-blasting or scarification for complete removal. Chemical removal will only dissolve the curing compound and drive it further into the surface of the concrete and unacceptable for bonding tile. Therefore, chemical removal products should be avoided. Other contaminants such as paint, spackling compounds, wood sealers and finishes must be removed by mechanical abrasion.

Tile Layouts

There are many aspects of a tile layout that increase the difficulty when installing large format tile. For one thing, there are less grout joints to lengthen or shorten the lineal measurement of a given number of tiles by changing the width of the joints. This makes it more difficult to make the tile cuts look evenly divided when multiple adjoining rooms are being tiled. There are fewer options for how wide the grout joint can be due to the size variations of the tiles themselves. The grout joints must be wide enough to compensate for the size variations caused by wedging (*out of square tiles*) as well as the tiles varying in size. This normally does not allow the usage of very narrow (credit card thickness) grout joints. The use of these tight joints should be discouraged.

12’ X 24” rectified porcelain tile installed using a 33% offset grout joint

With the growing popularity of large format and rectangular tile, guidelines are in place to assist the tile installer with issues such as determining the grout joint size and the amount of offset when the specification calls for a running bond or brick joint pattern. ANSI A108.02.4.3.8 defines grout joint requirements, including a minimum joint size while ANSI A108.02.4.3.8.1 describes running bond / brick joint patterns.

Tile Categories

Under the ANSI A137.1 Standard Specifications for Ceramic Tile, Porcelain Tile and Pressed Floor Tile are supplied in sizing categories. Porcelain tile is divided into; calibrated and rectified, while Pressed Floor Tile is divided into; Natural, Calibrated and Rectified. Natural tiles are not sized or sorted mechanically and can vary greatly in size. Calibrated tiles have been sorted to meet a manufacturer's stated caliber (size) range. The caliber range is acceptable as long as an appropriate sized grout joint is specified. Calibrated tile varies less in facial dimensions than most natural tiles, but can experience a wide size variance. Rectified tiles have had all edges mechanically finished to achieve a more precise facial dimension. They provide the least amount of facial dimension and squareness variance of the three types and can normally be used successfully with tighter grout joints.

Also covered in ANSI A137.1 is the range of acceptable thickness variation of tiles as well as warpage that is the allowable deviation from planarity (flatness) of a tile's surface. As mentioned, the grout joint widths are also governed by the warpage of the tile. So, as the tile warpage increases, so does the size of the grout joint.

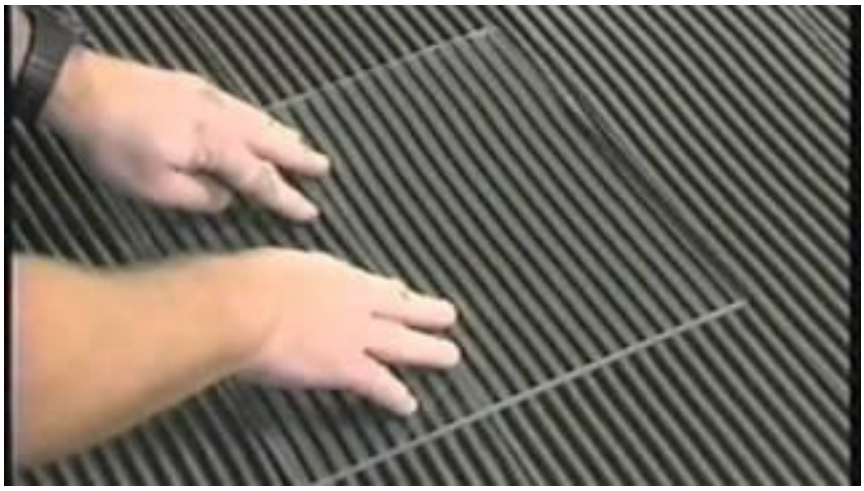
Coverage

Adequate mortar coverage is crucial to a quality installation. ANSI standards and TCNA *Handbook* methods provide the guidance necessary to meet this challenge. ANSI A108.5 and the *Handbook's* Field and Installation Requirements section list the coverage requirements for the various types of tile.

Many contractors install tile by spreading the setting material with the notched side of the trowel as they would with mastic, in a swirling pattern. This method does not apply the setting material properly which should use the flat side of the trowel to "key" the mortar into the substrate for a good mechanical bond. Swirl troweling also creates problems since it does not distribute the mortar evenly under the tile which provides less than adequate coverage on large format tile installations.

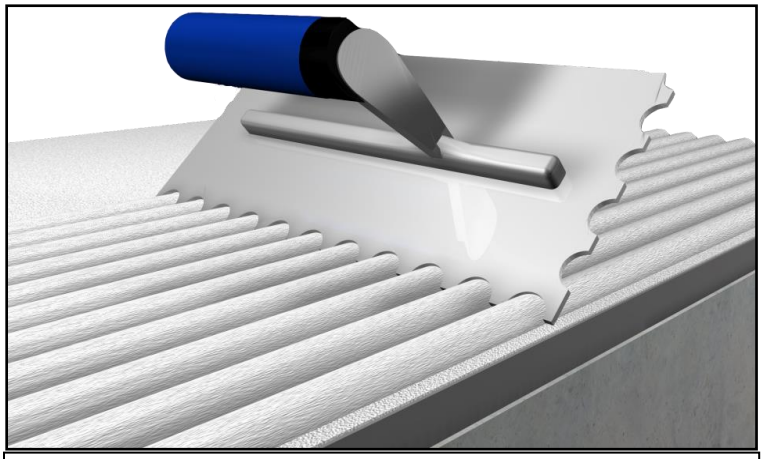
Properly selected notched trowels provide the appropriate amount of setting material to the substrate and yield an adequate bond. They also allow a path for the air under the tile to escape. This yields a mortar application that is void-free between the tile and the substrate. However, if the tile exhibits warpage on the long edge, an air space and a mortar void can occur under the middle of the tile. This trapped air has no way out since the setting material around the edges of the tile blocks its escape. This can be

one of the causes of hollow sounding tile. Additionally, if the setting material is applied with a notched trowel in a swirling pattern, those tunnels are effectively blocked trapping the air under the tile and produce poor coverage.



Straight troweling eliminates trapped air

However, a better method is available. Trowel the setting material in one direction, either left to right or top to bottom. Place the tile parallel to the mortar ridges; press the tile into the mortar while moving the tile perpendicular (at right angles) to the trowel ridges while applying pressure to embed the tile. This allows the air to escape, achieving close to full coverage. This technique became known as the *"Trowel and Error Method" of setting tile which was developed by the National Tile Contractors Association.



Proper mortar coverage under the tile is critical when installing LFT

This practice works well when installing large format tile and is especially helpful when setting rectangular tiles. Whether the job calls for a medium bed or a thin-set mortar, be certain to follow the manufacturer's recommendations on the proper notched trowel which meets the job requirements.

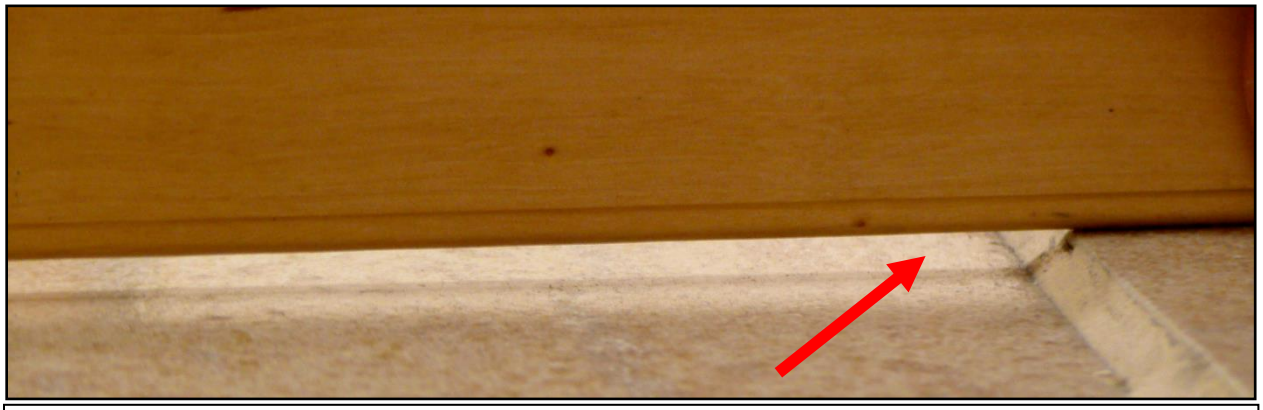
Lippage

Lippage is a major concern on any tile installation and even more so with large format tiles. Lippage is the difference in elevation between the edges of adjacent tiles which causes two issues. Walking safety is compromised when the tile surface is not flat

resulting in someone potentially falling. The second issue involves the surface appearance not being visually pleasing.

Many contractors have experienced lippage issues on vertical installations with wall wash lighting, where the lighting is placed directly above the wall line. During the installation, normally only temporary lighting is available which usually is not even close to the area to which tile is being applied. Once the permanent lighting is installed, the wall wash lighting at a very narrow angle to the tile plane not only shows lippage; it accentuates it, many times to an unsatisfactory level. Experienced contractors have learned to notify the architect or general contractor to get the permanent lighting type (*incandescent, halogen, florescent or LED*) installed in the permanent lighting location prior to installing the tile. If this is not possible, request to have the temporary lighting moved as close to the wall line as possible to imitate the permanent light location in a wall wash fashion. Additionally, requesting that the lighting be relocated away from the wall line will normally correct this situation.

Lippage becomes more noticeable on floor installations when the tile surface is illuminated by light from doors, windows or artificial lighting at a low angle. The light creates shadows that make customers unhappy. This situation is amplified when a highly reflective or shiny tile is used and can be even further accentuated when the installed grout joints are less than the minimum ANSI requirements. Always keep in mind that large format tiles compared to standard size tiles can increase the amount of lippage when applied to irregular substrates. The maximum amount of lippage for smooth finished natural stone installations is 1/32". The installation of pressed floor and porcelain tiles requires that the maximum allowable lippage be 1/32" when the grout joint width is 1/16" but less that ¼".



Example of extreme lippage on a tile floor installation

For successful large format tile installations, the installer needs a flat substrate (and fix it if not provided), proper setting materials, and installation techniques.