

Common Sources of Failure of Tile Decks on Wood Frame Construction

By John Ogilvie
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Our company has been involved in the waterproofing of decks and balconies for over 35 years and has supplied well over one hundred million square feet of membrane to professional contractors in the business. Having developed significant expertise in both the product and its application, it was natural that we would look at other areas in which our material (Duradek is a pvc



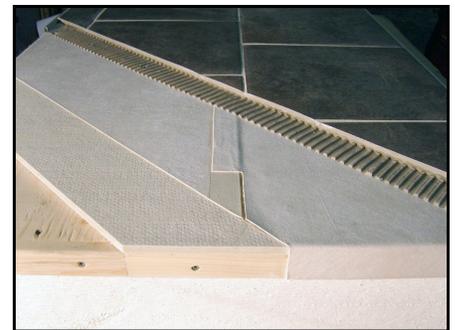
roof membrane capable of pedestrian traffic) might provide an equally valuable service.

One of our contractors in Florida had been applying a significant amount of our material to plywood-constructed decks as the waterproofing/roofing membrane over top of which porcelain tile or stone was being installed. Apparently, this was an area of great concern with very few suitable products available and a fairly high failure rate. Because our product had already been successfully used for many years (even though it was not designed or marketed for that purpose) under tile in a very severe climate, we felt there was a good opportunity to develop this idea further. We approached it on the basis of discovering why there were so many failures and what the mode of failure was. We talked to industry leaders in tile bonding adhesives, decoupling mats, anti-fracture membranes, cement backer units, envelope consultants and lots of experienced tile contractors who had been around long enough to see the results of working with the different materials that were available to them.

The most surprising thing we discovered was that that if you were willing to research the issue and look to the industry experts and follow the recommended “best practice” standards, the success rate would be dramatically increased. Simply knowing the questions to ask and who to ask is the first step to getting the right answers.

Some of the best advice given to us by a “long in the tooth” tile contractor was this: He tells his customers who are interested in having tile or stone outdoors (especially on a wood frame building) that if they don’t have a budget sufficient to do it properly they should not even consider it. Taking money-saving short cuts with an “assembly” that requires all the components to work together could prove to be extremely expensive in the long run.

For the purpose of this paper and to provide some order, we are going to begin at the bottom of that assembly and work up. We would also point out that we have no expertise in the installation of tile. Our expertise is in keeping the water out of living space beneath decks and balconies. The observations we present here are simply meant to direct the readers to the possibilities of problems so they can ask the right questions of the appropriate manufacturers or contractors.



Tile Deck Assembly From the Bottom Up:

Plywood, CBU, Waterproof Membrane, Thinset, Tile

Building the deck

Slope: Water needs to be “managed”. We need to direct it where to go. Puddles are annoying and are a potential source of damaging the tile assembly. The only way to accomplish this is with an adequate slope. Two percent (approximately 2.5 inches in 10 feet) is safe. Many people consider this excessive and try to reduce it, only to find later that with settling of the building, frame shrinkage and the possibility of the crowns on the floor joists not all being up, there are puddles. Too late!

Adding drains and scuppers adds to the degree of difficulty. It can be done with good design and very careful framing but the most simple and effective way to deal with water is to let it flow over the side of the deck.

Materials: Assuming the joist spacing and sizing is appropriate for a tile assembly, the choice of materials and how they are fastened together plays a very large part in keeping the grout lines from cracking or the tiles from popping off. The assembly needs to be very stiff and flat and built to substantially reduce structural deflection. A total thickness of at least 1-¼ inches is required.

Our research indicates the best practice is ¾ inch plywood with a ½ inch cement backer unit (cbu) fastened on top. Plywood can also be used on top depending upon the climate and if it is over “conditioned” space. This needs to be researched locally. Whatever is used should be fastened with thinset bonding adhesive and appropriate screws. The joints of the overlay should not be over top of the joists. They should be one quarter of the distance to the next joist. The fasteners should only be long enough to attach it to the plywood beneath, not to the joists to allow it to “float”.

Flatness is important. If there are humps and bumps, puddles can be created which cannot be easily resolved by floating it with filler later on. Any flatness issues need to be dealt with before the waterproofing membrane is applied.

Waterproofing

We discovered a great lack of understanding of the importance of this step. Is this deck the roof over habitable space? Does it require a roofing membrane to meet the local building code? Should that membrane be applied by tradesmen who specialize in roofing details or by tile setters? Is the membrane suitable for tile to be applied to? Is it compatible with the polymers that are part of the thinset bonding adhesives? Is it firm enough to prevent cracking of the tiles? Will it soften in the heat and still support the tile assembly? Has it been tested with the Robinson Floor test to meet the traffic requirements of the job? Does the manufacturer guarantee it for this end use?

We were surprised at two things: first, the number of beautiful tile jobs that failed partly because they were installed over torch-down

roofing, a material that is not compatible with the bonding adhesives, is too soft, has no testing to support its use for this application and in fact is not guaranteed by any of the manufacturers for this end use; and second, by the lack of



Failed Tile Job

understanding of the need of waterproofing in the first place (we assume its because they may think the tile assembly is waterproof by itself).

Our theory is this: the tile assembly is expensive, but a popped tile or cracked grout joint is relatively easy to repair. The lack of adequate waterproofing can result in rot and structural repairs that can be extremely costly.

One of our contractors in the San Francisco Bay area recently completed a repair of a failed tile job that involved a new ceiling, replacement of rotted floor joists, door removal and obviously a whole new tile installation, this time with an appropriate roofing membrane protecting the house. The problem? There was a waterproofing membrane present, but it was not a roofing membrane nor



was it installed with “roofing” details and most likely by the tile setter who never professed to be a roofer.

The repair was over \$70,000 for a deck that was only about 500 square feet. It could have been avoided by spending an extra few dollars per square foot to have a proper tile compatible, roofing membrane installed in the first place.

Details: Roofing is all about the details. Failures seldom happen in the center of a roof, but usually on the perimeters. Special attention is to be paid to corners, door openings, posts, pony walls, drains, scuppers, outside perimeter finish, inside perimeter (up the wall behind the siding and building paper), railing attachments and more. Examples of these details can be seen at www.duradek.com/tiledckCADDDrawings.html.

Waterproofing or roofing? There are many manufacturers who offer waterproofing products that are suitable under tile. There are only a few that offer roofing materials for this purpose. Our question is this: what is the difference? It is either capable of keeping the water out or it isn't. You can't be “almost” waterproof! The answer is in the liability the manufacturers are willing to take (roofing infers a lot more liability than waterproofing) and most importantly, the skills required for properly applying the membrane. We

believe this requires professional installation by tradesmen familiar with the intricate details that decks and balconies present.

Uncoupling/Drainage Mat

There seems to be at least two theories about the necessity of a drainage or uncoupling mat.

One is that tile or stone can be bonded directly to an appropriate membrane (assuming there are some crack isolation properties in that membrane) with the appropriate thinset adhesive. That thinset, obviously the one recommended by the manufacturer for that specific climatic region and for the specific job conditions, can withstand the elements and provide the adhesion required even in the presence of moisture.

The other theory is that since water is going to penetrate the grout lines and get under the tile, a drainage plane needs to be provided to allow it to escape. This brings up some other issues such as the method of fastening the drainage mat (with a thinset bonding adhesive but not necessarily the same one used to bond the tile). Following the manufacturer's recommendations is essential for success and to ensure warranty coverage.

Crack isolation: The assembly has little tolerance for movement and is likely to crack if there are not steps to reduce (isolate) the movement of the subsurface from the tile/grout assembly. The waterproofing membrane will likely provide some crack isolation protection itself and the addition of a drainage/decoupling mat will increase it significantly.

Our best advice is to research this carefully for the specific conditions the job presents. Choose a system that makes sense and carefully follow the manufacturer's specifications.

Thinset Bonding Adhesive

The desire to save money by choosing a less expensive thinset has been a very large source of failure. To those who are unaware of the technology involved in a polymer-modified mortar used as an adhesive to bond tiles, they may all look the same and therefore have the same properties. Nothing could be further from the truth. Here are some of the properties required in a thinset adhesive for outdoor tile installations.

Flexibility: The higher priced thinset mortars have higher quality polymer additives that allow for more movement. Consider an elastic waistband. Eventually, it wears out and loses its elasticity. The better quality the elastic, the longer it lasts. With the constant movement resulting from changing temperatures, the thinset is trying to hold the tile in place. The better quality the thinset, the longer it continues to provide the adhesion required.



Efflorescence on Tile

Efflorescence: The white stains that seem to ooze out of the grout joints or from the outer edge of the tiled surface might be a result of the wrong choice of thinset or grout material. The manufacturer will recommend the correct materials to be used to reduce or eliminate efflorescence.

Curing time: Outdoor installations are obviously susceptible to dramatic temperature and humidity fluctuations. Some very experienced tile setters won't do an outdoor job unless it can be tarped off to keep it out of the direct sun and rain for a significant period of time to allow for the proper curing of the materials. There are fast setting thinset adhesives available for cooler temperature installations. Once again, seek out the manufacturer's recommendations and follow them.

Freeze/thaw capabilities: The thinset must be capable of continuing to perform its duties even wet and under freezing conditions.

Re-emulsification: A surface that is not properly built and prepared may provide small areas that allow water to puddle. Prolonged dampness may promote the re-emulsification of the mortar that would impact the adhesion. The manufacturer will provide guidance on this issue.

Choosing the tile or stone

Some of the failures of outdoor tile jobs are caused by wrong product choices. Freeze/thaw resistance and water absorption characteristics are available. Make sure the product is matched to the climate it will be installed in. One example of a failure we saw was a slate tile installed in a region that experiences many freeze/thaw cycles each year. The stone was "flaking" apart which could have been predicted considering the properties of that particular product. If the supplier does not have the information, choose another product or supplier.

Installation techniques

Obviously the skill of the tile setter is extremely important to the eventual success of the job. There are a few installation issues we saw that play a major role in the success of an outdoor tile job.



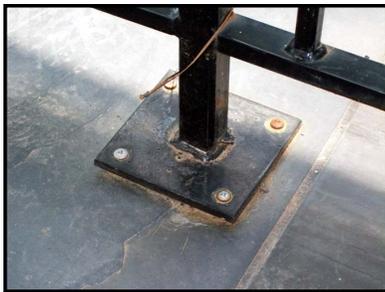
Thinset Coverage Should be 100%

100% coverage of the thinset: Voids in the thinset coverage will provide space for moisture to collect. While difficult to completely avoid air spaces, the goal is to get 100% coverage of the bonding adhesive.

Soft Joints: Tile, thinset and grout are rigid materials. The tiled assembly is going to have substantial movement as the temperature changes and provision needs to be made to allow for that movement. Industry standards call for soft joints (joints that allow for movement) to be placed every 8 to 10 feet in either direction. It will most likely be visibly different than the other grout joints and as a result, some choose the appearance over the function and suffer the consequence of erupting tiles. The laws of nature will always prevail.

Railings

Never, never, never attach a surface mounted rail on top of a tile or stone finish!



Surface Mounted Railing

The fasteners required to hold the rails will penetrate the roofing membrane. Water flows on top of the waterproofing membrane. Any penetration of the membrane will be almost impossible to seal and at any rate, is a very bad practice.

The other issue with a surface mounted rail relates to the likelihood of cracking the tile as you tighten the fastener.

The best practice is to mount the rails on the fascia or on a curb. Details can be seen at www.duradek.com/durailcaddrawings.html.

If the rails are mounted on posts that penetrate the deck surface, special provision must be made to provide a waterproof “collar” up the post.

Maintenance

The technical director of a major thinset manufacturer recommended that applying the appropriate sealer on a regular basis to the tile

and/or the grout will reduce the amount of moisture that penetrates the system and help to prolong the life of the assembly.

There are few outdoor surfaces as attractive and durable as tile or stone and they can be used outdoors even in very extreme climates providing there is a great deal of care put into the choices of materials and trades people. As so often happens, attempts to cut corners on costs or by taking shortcuts, even ones that seem to make sense, result in the most expensive installations. The common themes in this report are to follow the manufacturer’s recommendations to the letter and employ only experienced professionals for each part of the job. The chances of a successful, long lasting installation increase exponentially if you do.

This article is written by John Ogilvie, President and one of the owners of Duradek Ltd. Duradek has been waterproofing decks and balconies since 1974. Its products are only installed professionally by contractors trained and supported by Duradek and its network of distributors throughout the United States and Canada. The specific product referred to in this article is Duradek Ultra Tiledek, a roof membrane specifically designed and tested for the application of tile or stone overlays. More information can be found at www.duradek.com/tiledek.



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