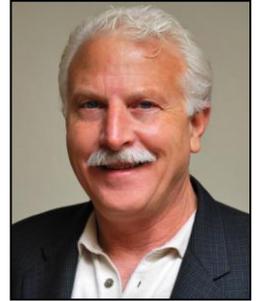


# HOLLOW SOUNDING TILES MAY SIGNAL

# INSTALLATION PROBLEMS

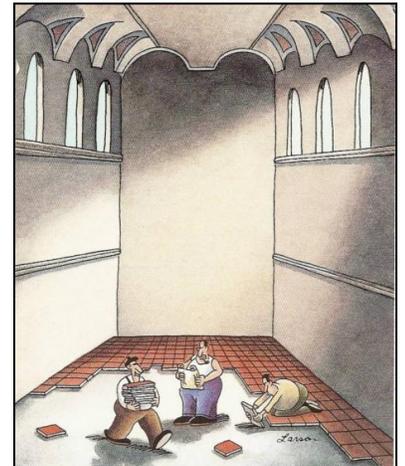
Donato Pompo CTC CDT CMR MBA has worked in the ceramic tile and stone industry for over 30 years. He has worked as a union installer, an importer and distributor for 17 years, and a sales manager for an international manufacturer of installation products for 7 years. Donato has operated his own consulting business for over 8 years. He has a biochemistry education with an MBA. Donato is also the founder of the University of Ceramic Tile and Stone that produces online sales and installation training courses and other training services. He is a certified construction document technologist (CDT), a certified microbial remediator (CMR), and he is a certified ceramic tile consultant (CTC). Donato is a member of the industry standard committees of ANSI A108, ISO TC189, ASTM C18, and participates in the TCNA Handbook committee, the NTCA Technical Committee, MIA Technical Committee, and the CTIOA Technical Committee. Donato is the current chairman of the Ceramic Tile Distributors Association Education Committee and a Floor Covering Institute consultant. For more information on Donato and his company, Ceramic Tile And Stone Consultants, visit [www.CTaSC.com](http://www.CTaSC.com) or email [Donato@CTaSC.com](mailto:Donato@CTaSC.com). Donato is also an associate of LGM as a Ceramic Tile and Stone expert.



## HOLLOW SOUNDING TILES MAY SIGNAL INSTALLATION PROBLEMS

When ceramic tile or stone tile fails, it doesn't matter whose fault it is, everyone ends up paying – either in money, time or reputation.

Typically, ceramic tile and stone failures are a result of not *one* deficiency, but *multiple* issues. As an expert consultant I investigate ceramic tile and stone installation failures all over the country, and have for many years. More often than not, the visual and intrusive inspections shows that compounding factors are to blame for tile failures. The best way to ensure a successful tile installation and avoid problems is to make sure substrates are properly prepared, tile is installed per industry standards and methods, and that the installation products are installed per the manufacturers' directions.



*Although history has long forgotten them Lambini & Sons are generally credited with the Sistine Chapel floor.*

### Hollow Versus Solid Sounding Tiles

A common symptom we come across in investigations is ceramic or stone tile ("tile") that sounds *hollow*. A simple way to check for the sound in question is to tap on the tiles with a hard object such as a steel ball bearing. Chains or special sounding devices can be used for larger areas. If the tile is well bonded (i.e. attached to the concrete substrate), it will have a high-pitched sound. If you hear a lower-pitched or a *hollow* sound, this can be an indicator of tiles that have debonded somewhere within the tile assembly.



It doesn't automatically mean your tile installation is destined to fail. A low-pitched sound can also occur and *not* signify there is a problem – the type of sound you hear also depends on the configuration of the tile assembly. For example, when tile is installed over a less dense substrate as in the case of wood, a non-bonded mortar bed, a sound control mat or over a steel frame, wall tapping often produces a hollow sound even if the tile is attached well.

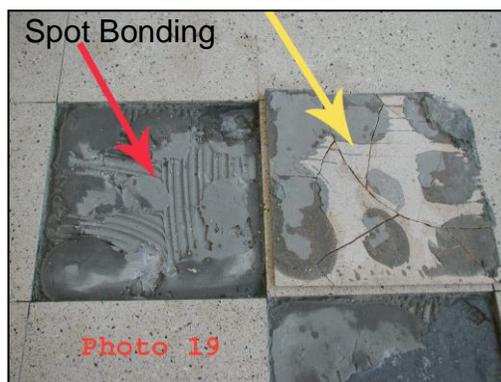
Depending on the tile assembly configuration, the hollow sound can be higher-pitched and the solid sound can be lower-pitched rather than vice-versa.

So how does one determine whether the elusive “hollow” sound is *the bad* type? If an entire tile installation sounds hollow it may be a result of the type of substrate that was used, like the ones I just mentioned (less dense substrates). In my experience I've rarely seen an entire installation that's debonded unless there are other symptoms like loose or cracked tile or grout.

The debonding problem is usually found when there's a differential in sound *from one area of an installation to another*. Let me explain: if investigating a 1,500 square foot ceramic tile floor in a restaurant and I sound the entire area, calculating that only 75% of the tiles sound “solid” and 25% sound hollow, this can raise a red flag. The hollow sounding areas could signal several things: the thin-set adhesive could have debonded from the back of the tiles, or the thin-set could have debonded from the substrate. If the substrate is a bonded mortar bed, it's possible that the mortar bed has debonded from the concrete slab. The other question is whether the 25% of solid sounding tiles are in trouble of debonding also, but at a later date.

### Spot-Bonding

Hollow sounds produced by tapping tiles can also be a result of an improper installation method called spot-bonding. Spot-bonding is when an installer applies “spots” of adhesive on each corner of a tile and one in the center, and then presses it into place. This leaves voids under the tile, and ultimately throughout the entire installation, which can lead to big problems. When this method has been used you'll hear the hollow sound where there is no adhesive (the voids) and you'll hear solid sounds where the tile is spot-bonded.



The spot-bonding method is a problem in several ways. First, it does not meet industry standards. For commercial floors, exterior applications and interior wet



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applications such as showers, the ANSI standards require 95% thin-set contact between tile and substrate with no voids greater than 2" x 2" and must have full thin-set contact at all tile edges and corners.

The second negative issue with spot-bonding is that it reduces the bond strength of the tile and its attachment to the substrate. For example, if the surface area of the adhesive spots only amount to 25% of the entire surface area of the back of a tile, then the potential bond strength has been reduced by 75%. This factor would make the tile more susceptible to stress and could cause it to debond under certain conditions.



The third issue with spot-bonding is that the voids created below the tiles become little pockets for water and/or moisture to collect that could lead to efflorescence and other moisture-related problems.

And last, but not least, the voids under the tiles will be more vulnerable to damage if subjected to live loads such as falling heavy objects, heavy equipment, rolling vehicles, loaded dollies, carts, etc, because they're not fully supported under those voids.

The only time spot-bonding is considered a legitimate installation method is when used either for mechanically anchoring stone slabs or in tile applications using an epoxy adhesive for a ventilated wall system. Unfortunately it is often incorrectly used in other situations by installers that are either inexperienced or not up-to-date on industry standards.

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## Forensic Investigation

The only way to substantiate if tiles have debonded and to determine what has caused this problem is to remove samples from different areas of the installation for comparison – some that are hollow sounding and some that are solid sounding. By extracting pieces of tile and substrate(s) you can, 1) determine what's different in the assemblies of the hollow vs. solid sounding tiles and, 2) determine whether individual defective tiles can be simply repaired or if the entire installation needs to be replaced. Removing solid sounding tiles not only shows differences in how it was installed, but can also show similarities to hollow sounding tiles. That is, sometimes solid sounding tiles have also been improperly installed, but have not been subjected to the same stresses as tiles in other areas; these tiles may look okay, but they may eventually debond and need to be repaired.

## Causes for Debonded Tiles

Some common reasons why tiles debond are:

1. The concrete substrate is not properly prepared. Curing compounds are often used on concrete and act as bond breakers – a problem that is growing exponentially for all flooring materials. Also, sometimes a concrete surface is too dense and doesn't absorb moisture well enough to allow thin-set to achieve an adequate bond. Substrates under these conditions should be scarified before any tile work is done in order to remove contaminants and to open the concrete's pores. (A future issue of CFR is devoted to this issue.)
2. The backs of the ceramic or stone tiles are not properly cleaned before application. Dirt and manufacturing residues are contaminants and act as bond breakers. All tile backs should be cleaned prior to installation.
3. Thin-set mortar adhesives will "skin over" during the curing stage and will lose tackiness, thereby reducing the bond to the tile. This is caused by thin-set not being mixed or slaked properly (*slake: allowing thin-set to rest after mixing so chemicals can dissolve*). Thin-set that skins over can also be caused by applying the thin-set over a

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substrate that is too porous and applying it too far in advance of the actual setting of the tile.

4. Other factors that contribute to debonding are excessive floor or wall deflection (vertical movement) and the lack of movement joints (expansion joints).

**Conclusion**

The best way to ensure that you don't end up with tile and stone installation problems is to verify that installers are following industry standards. Installers usually do not have formal training and typically learn on the job. Frequently they do not know all of the industry standards, and they may become complacent and do a rushed installation, particularly when the general contractor is pushing them. Tile is a finishing product installed at the end of a job, so installers tend to take the brunt of the pressure to hurry-up in order to make up for the lost time of other tradesmen on a job.

It's very important to have clearly written architectural specifications providing for specific quality assurance requirements to ensure that the right products and methods are used for the intended applications. In addition, a specific quality control plan should be called out in the architectural specifications to be implemented by a third party. Architects generally do not use consultants to assist them in their tile specifications, as they do with other applications on their projects. Ceramic tile and stone applications can be very complex, with higher risks for some applications such as wet areas and exterior veneers. Selecting a natural stone for a project is not a simple process, as different stones, even those within the same geological classification, have different physical properties and may or may not be suitable for the intended use. So architects should budget in their proposals to their clients the cost of a tile expert to help avoid costly mistakes. Far too often installers themselves are specified to provide their own quality control on a job, which is clearly a conflict of interest. Requiring that a qualified third party company be used for quality control should put building owners and their insurance companies at ease by ensuring that tile installations are done correctly from the beginning. This will avoid potential expensive failures and liabilities in the future. It's a lot cheaper to spend the money up front and have an installation done right the first time, rather than having to pay for it to be ripped out later and replaced! LGM is heavily involved in spec writing for flooring materials and can provide this service. [lgmandassociates.com](http://lgmandassociates.com)



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## Concrete Moisture Testing Technician Certification – Grade I

The International Concrete Repair Institute (ICRI) is pleased to introduce their Concrete Moisture Testing Technician Certification Program. The purpose of this program is to help improve the performance of concrete slab moisture testing in the U.S. to result in more consistent, accurate results that will help flooring manufacturers, architects, and contractors to make better decisions as to when a concrete floor is ready for a floor covering installation.

The certification program has 2 tiers. Tier 1 applicants are those who are not regularly engaged in moisture testing yet have an active interest in learning more about the tests, what the tests mean and how the tests should be performed. Tier 2 applicants are those who have applied for full certification. Both tiers require attendance at a 3 hour educational session followed by a written exam. Tier 2 full certification applicants will also be required to perform each of the 4 tests under the watchful eye of a qualified judge who will not provide any level of coaching. Prequalification for acceptance into full certification Tier 2 will be previous testing experience.

Tier 1 consists of a 3 hour educational session, a written exam and a training session. Those who complete the course and pass the exam will be issued an ICRI Letter of Education. Tier 2 consists of the same 3 hour educational session, the written exam and a field performance exam. By passing both the written and performance exams, an ICRI Concrete Moisture Testing Technician - Grade I certification will be issued to those who successfully demonstrate their knowledge and ability to properly perform and record the results of each of the four field moisture tests on hardened concrete. Those who pass both the written and performance exams will receive a certificate and wallet registration card.

Both the written exam and the field tests will be based on the following four (4) ASTM Standards, including all Annexes and Appendices:

F 710	Preparing Concrete Floors to Receive Resilient Flooring; Section 5.3 pH Testing
F 1869	Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride
F2170	Determining Relative Humidity in Concrete Floor Slabs Using <i>in situ</i> Probes
F2420	Determining Relative Humidity on the Surface of Concrete Floor Slabs Using Relative Humidity Probe Measurement and Insulated Hood

ICRI Certification for Slab Moisture Testing Technician– Grade I shall be valid for a period of five [5] years from the date of completion of all applicable certification requirements.

The two day certification program begins on the first day with registration from 8 - 9 am, followed by the 3 hour educational session. There will be a provided lunch and study break from 12 – 1 pm followed by the written exam from 1-2 pm. Following the written exam Tier 1 students will attend a training session where they may receive or observe hands on training on how to properly perform each of the four tests.

For those registered for the Tier 2 Certification, day two begins at 8 am, and each applicant will be required to perform all 4 ASTM tests listed above.

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