

A Hard Look at “Hard Troweling” of Air-Entrained Concrete

Q. *I'm working on a project that requires hard troweling of air-entrained concrete. Will hard troweling of concrete with an air content below 3% or using combo blades on concrete with an air content exceeding 3% prevent blister formation and delaminations?*

A. There are more than 18 industry documents from ACI, National Ready Mixed Concrete Association (NRMCA), Portland Cement Association (PCA), American Society of Concrete Contractors (ASCC), and other organizations that warn against “hard troweling” concrete with more than 3% total air content.¹⁻¹⁸ Although the aggregate in lightweight concrete may reduce the amount of bleed air relative to normalweight aggregate, providing a trowel finish on a lightweight concrete floor with more than 3% air is also risky and not recommended.¹⁹ As much as I agree with the warnings, however, the problem really goes beyond “hard troweling.”

First, I have dealt with finishers who have claimed that they NEVER got on the concrete with “trowels,” so they didn’t violate the warning. However, I’m sure that many of them used combination (combo) blades with the leading edge tilted up. Although the packaging for their combo blades might not have included the word “trowel,” they did indeed violate the warning. Here’s why: A float blade has turned up leading and trailing edges, a trowel blade has flat leading and flat trailing edges, and a combo blade has a turned up leading edge and a flat trailing edge (it’s an intermediate float/trowel blade). If the finisher tilts a combo blade (raises the leading edge), the trailing edge behaves exactly like the trailing edge on a trowel blade.

Second, I have heard about consultants who have suggested that finishers didn’t “hard trowel” the surface—they only “troweled” the concrete, so they couldn’t have caused delaminations. Unfortunately, the word “hard” does not represent the level of effort or energy put into the troweling

process. In fact, there is no definition for “hard trowel,” and there is also no way to determine if a surface was “hard troweled” versus “troweled.”

I am certain that the term “hard troweling” has its origins in early specifications for trowel blades. To ensure long wear, trowel blades are hardened by quenching—rapid cooling of hot steel to room temperature. Specifications probably evolved from “finish with hardened-steel trowel blades,” to “provide hardened-steel trowel finish,” to “provide hardened-trowel finish,” and finally to “provide hard-trowel finish.”

In my opinion, as an industry, we need to remove the word “hard” from “hard troweling.” Even better, change “troweling” to “power finishing.” But baby steps might be easier. When manipulating the surface with any type of modern power finishing equipment, whether using a pan float, float shoes, combo blades, or trowel blades, the tiny air voids tend to coalesce into larger voids that can become flattened and elongated under repetitive passes of the equipment. It’s typical to get between 1.8 and 2.2% entrapped air in non-air-entrained concrete, but 3% is the industry standard maximum “total air” recommended to be troweled. While 3% is not a magical number, the higher the total air content (both entrained and entrapped), the greater the risk of blisters or delaminations. In my experience, 2.9% was the lowest total air content attributed to delamination. And the risk jumps with each percent increase, such that at 6% air content is very risky, and at air contents above 8%, it’s nearly impossible to avoid creating blisters and/or delaminations. I’ve seen concrete with 12 and 13% air—the finishers didn’t have a chance to finish it safely.

Questions in this column were asked by users of ACI documents and have been answered by ACI staff or by a member or members of ACI technical committees. The answers do not represent the official position of an ACI committee. Comments should be sent to keith.tosolt@concrete.org.

Concrete Q&A

As I noted previously, the word “hard” is problematic. I and others are therefore working to have the term removed from ACI’s guides and standards. I think we can successfully change “hard troweled” to “troweled” in ACI 302.1R, for example,¹ but “power finishing” may be too much of a stretch.

And the issue extends beyond floors. I have seen many contractors using ride-on finishing equipment on air-entrained exterior concrete. These are probably floor contractors who have taken on pavement projects to keep their laser screeds employed. While this is a good business decision, the final finishing should be done using bull-floats and brooms—not ride-on finishing equipment. Tractor trailer trucks don’t require super flatness, and they don’t (or shouldn’t) travel at high speeds in parking lots. However, finishers accustomed to working on floors will be tempted to make quick work with a ride-on pan float. While they may have successful outcomes most of the time, they’re right on the edge of problems. And I know this because I am occasionally called upon to solve delamination issues caused by such finishing practices.

Lastly, note that the factors leading to delaminations are not limited to the finishing operation, the finishing tool, or the air content of the concrete. The degree of set is equally important. I’ve even seen blisters and delaminations caused by troweling of air-entrained concrete using nylon trowel blades, so avoiding hardened-steel trowel blades may not eliminate the risk of blisters and/or delaminations.

References

1. ACI Committee 302, “Guide to Concrete Floor and Slab Construction (ACI 302.1R-15),” American Concrete Institute, Farmington Hills, MI, 2015, 76 pp.

2. ACI Committee E703, “Concrete Craftsman Series: Slab-on-Ground (CCS-1(10)),” third edition, American Concrete Institute, Farmington Hills, MI, 2010, 68 pp.

3. ACI Committee 212, “Report on Chemical Admixtures for Concrete (ACI 212.3R-16),” American Concrete Institute, Farmington Hills, MI, 2016, 76 pp.

4. ACI Committee 306, “Guide to Cold Weather Concreting (ACI 306R-16),” American Concrete Institute, Farmington Hills, MI, 2016, 24 pp.

5. ACI Committee 301, “Specifications for Concrete Construction (ACI 301-20),” American Concrete Institute, Farmington Hills, MI, 2020, 69 pp.

6. AIA MasterSpec, “Section 03300 – Cast-in-Place Concrete,” The American Institute of Architects, Washington, DC.

7. “CIP 20 - Delamination of Troweled Concrete Surfaces,” National Ready Mixed Concrete Association, Alexandria, VA, 2018, 2 pp.

8. Tarr, S.M., and Farny, J.A., “Concrete Floors on Ground,” *EB075*, fourth edition, Portland Cement Association, Skokie, IL, 2008, 252 pp.

9. Kosmatka, S.H., and Wilson, M.L., “Design and Control of Concrete Mixtures,” *EB001*, 15th edition, Portland Cement Association, Skokie, IL, 2011, 444 pp.

10. Collins, T.C.; Panarese, W.C.; and Bradley, B.J., “Concrete Finisher’s Guide,” *EB122*, Portland Cement Association, Skokie, IL, 2017.

11. ASCC Position Statement #1: “Hard Trowel Finish on Air-Entrained Concrete,” American Society of Concrete Contractors, St. Louis, MO, 2011, 1 pp.

12. “The Constructor’s Guide to Quality Concrete Construction,” third edition, American Society of Concrete Contractors, St. Louis, MO, 2014, 147 pp.

13. “Guide for Surface Finish if Concrete Slabs on Ground,” American Society of Concrete Contractors, St. Louis, MO, 2006, 21 pp.

14. Suprenant, B.A., and Malisch, W.R., “Diagnosing Slab Delaminations,” *Concrete Construction*, three-part article, Jan., Feb., and Mar. 1998, 4 pp., 5 pp., and 5 pp., respectively.

15. Suprenant, B.A., and Malisch, W.R., “Beware of Troweling Air-Entrained Concrete Floors,” *Concrete Construction*, Feb. 1999, 2 pp.

16. Bimel, C., “Is Delamination Really a Mystery?” *Concrete International*, V. 20, No. 1, Jan. 1998, pp. 29-34.

17. Lankard, D.R., “Air Entrainment and Delaminations,” *Concrete International*, V. 26, No. 11, Nov. 2004, pp. 21-30.

18. Tarr, S.M.; Kozikowski, R.L.; and Sheehan, M.J., “Guide to the Design and Construction of Concrete Toppings for Buildings,” American Society of Concrete Contractors, St. Louis, MO, 2022, 94 pp.

19. Kozikowski, R., “Concrete Q&A: Density of Lightweight Concrete,” *Concrete International*, V. 34, No. 8, Aug. 2012, pp. 74-76.

Thanks to Scott Tarr, North S.Tarr Concrete Consulting, P.C., Dover, NH, USA, for providing the answer to this question.

HUNDREDS OF
Concrete Standards,
Courses, and
Recommended
Practices Available



American Concrete Institute
Always advancing