
Industry Best Practices

By



ILLINOIS READY MIXED
CONCRETE ASSOCIATION

The Effect of Air-Entrainment in Troweled Flatwork in Normal Weight Concrete

IF AIR-ENTRAINED CONCRETE IS ORDERED, OR ORDERED IN A REDUCED AMOUNT THAT IS TYPICALLY LESS THAN THE RECOMMENDED AMOUNT TO PRODUCE FREEZE-THAW DURABLE CONCRETE, USED IN INAPPROPRIATE APPLICATIONS SUCH AS HARD TROWELED SURFACES OR PAVEMENTS REQUIRING A BURNT FINISH, OR IF NON-RECOMMENDED PRACTICES ARE EMPLOYED, THE CONCRETE PRODUCER CANNOT BE HELD RESPONSIBLE FOR DELAMINATION, SCALING, STRENGTH, OR ANY PROBLEMS THAT MAY OCCUR RELATED TO THE IMPROPER AIR CONTENT AND FINISHING PRACTICES.

The primary purpose of entrained air is to make normal weight concrete more resistant to the stresses caused by freezing and thawing cycles. The microscopic bubbles which enable this resistance have other sundry effects, such as inhibiting the migration of water to the surface during the setting process. They slow down and reduce the rate of “bleeding”. Because of this, caution must be taken not to seal the surface by prematurely finishing it before the concrete has had time to set and bleeding has stopped. If the concrete is prematurely troweled a thin layer of non-air entrained, non-durable cement paste is created. When the concrete has not achieved initial set, the bleed water which is still migrating to the surface becomes trapped under the thin layer of paste, causing a separation of that surface paste and the rest of the slab which forms blisters that may delaminate.

Surface defects such as delamination or scaling may occur with interior as well as exterior concrete. Scaling of the surface may be caused by freezing and thawing cycles (the most common type of scaling) or concentrated loads on an interior floor such as caused by fork lift traffic.

If the concrete is not going to be exposed to freezing and thawing cycles, then air entrainment should not be specified or used. Sometimes contractors order “half air” or approximately 3% air when air is specified and the slab is going to be troweled. If this done with exterior concrete, durability is compromised. Another common practice is to order “half air” in concrete that is placed over a vapor barrier, such as basement floors, in an effort to slow down the rate of bleeding. What typically isn't

being considered is the increased potential for delamination, scaling, blisters and, cracking that this practice causes.

Factors that exacerbate the effects of premature finishing are slump, setting time, environmental conditions, slab thickness, the condition of the base material and type of finish.

1. Higher slump concrete (especially when caused by excessive water) bleeds more. Longer set times caused by higher slumps, cooler environmental and concrete temperatures, admixtures, lower cement contents or high amounts of supplementary cementitious materials can enable concrete to bleed slowly for extended periods. Under ideal conditions, bleeding is complete at the same time that concrete reaches initial set. Wind, temperature, sun and shade all affect how rapidly water is evaporated out of the surface. When the surface appears to be dry, it can mislead the contractor to think that it's time to begin the final finishing operations, which can trap bleed water under the surface. Overworking a dry surface may cause "scrubbing" of the surface, delaminating the surface mortar.
2. Thicker slabs take longer for bleed water to migrate to the surface. This is especially a concern if slumps are excessive.
3. Care should be taken not to pour on wet or frozen bases. Set times and the amount of bleed water are increased.
4. Depending on the use of the slab it may be floated and broomed, hand troweled and broomed, hand troweled or machine troweled. For safety purposes exterior slabs are normally broomed, providing slip resistance. Interior slabs are steel or machine troweled to achieve a required flatness and appearance. In all cases, steel or machine troweling can more easily seal the surface. Whether interior or exterior slabs, caution must be taken to make sure the concrete is not prematurely troweled before the concrete has set and bleeding has stopped.

Industry Standards

Portland Cement Association (PCA):

- Premature floating and troweling can cause scaling, crazing, or dusting and produce a surface with reduced wear resistance.
- Exterior concrete should typically not be steel troweled, since this technique densifies the surface and reduces the air void system which is needed for freezing and thawing resistance.

American Concrete Institute (ACI):

C302 Concrete Floor and Slab Construction

4.1 Air-entraining agents should not be used in floors that are to have a dense, smooth, hard troweled surface.

6.2.7 An air entraining agent should not be specified or used for concrete to be given a smooth, dense, hard-troweled finish because blistering or delamination may occur. These troublesome finishing problems can develop any time the total air content is in excess of 3%.

8.3.11 Air entrained concrete should never be used in any normal weight concrete floor slab that is to receive a hard troweled finish. By hindering the passage of bleed water to the surface such purposeful air entrainment can compel the finisher to start the finishing process too quickly, leading to entrapment of a layer of water and air immediately beneath the prematurely closed surface.