

## Air Entrainment in Interior and Exterior Concrete Slabs

**Q.** *I'm designing two concrete slabs: one interior for a freezer and one exterior. Since both slabs will be exposed to freezing, should I specify entrained air for both concrete mixtures?*

**A.** There are many benefits of air entrainment, including improved durability, improved workability, and reduced bleeding. However, air entrainment is neither universally needed nor always useful. High air content will reduce unit weight but will also reduce strength and increase the potential for surface voids or defects.

ACI 302.1R-15, Provision 8.4.7,<sup>1</sup> cautions against specifying a combination of air entrainment and a smooth hard-troweled slab surface. It states: "Air-entraining admixtures should not be specified or used for concrete to be given a smooth, dense, hard-troweled finish because blistering or delaminations could occur." Likewise, ACI 301-16, Provision 4.2.2.4(d),<sup>2</sup> states: "Concrete for slabs to receive a hard-troweled finish shall not contain an air-entraining admixture or have a total air content greater than 3 percent."

The combination of air entrainment and a hard-troweled finish has been investigated and reported to be problematic since the 1980s.<sup>3</sup> Yet, the occurrence of surface delaminations or blisters from finishing air-entrained concrete is still too common.<sup>4</sup> The finishers must avoid sealing bleed water or bleed air beneath the densified surface,<sup>5</sup> but the air entrainment makes timing finishing operations difficult to impossible.

Can an air-entrained concrete slab be given a hard-troweled finish? Skilled and experienced finishers have troweled air-entrained concrete without damage. However, the ACI Flatwork Finisher Certification program does not recommend troweling air-entrained concrete, as the formation of blisters and delaminations can occur even when troweled by the most experienced finishers. If there is minimal need for protection against freezing-and-thawing damage, it is safest to avoid the use of air. While a broom-textured finish is recommended for a slab that could be saturated and subject to freezing-and-thawing cycles, this finish type does not provide wear-resistance equivalent to hard-troweled surfaces.

Freezers are cold-storage warehouses, so freezer floors are normally constructed with a hard-troweled surface. While the floors must be cleaned periodically (this may be done using steam cleaners), the concrete will not be saturated, and the

thermal capacitance of the slab will be too large to result in thawing. Therefore, low air contents (less than 3%) have been found to serve well in this environment. The risk of compromising the surface quality may not justify the desire to air-entrain concrete that will experience relatively few freezing-and-thawing cycles during its service life. For a discussion of special considerations for slabs for freezer facilities, refer to Reference 6.

Be aware, however, if a concrete mixture with low air content (less than 3%) is used in a slab placed at the end of the construction season, it must be thoroughly covered to prevent saturation. Exposing a non-air-entrained slab to freezing and thawing will leave this concrete vulnerable to damage.

Lastly, the exterior slab cast in a mild to severe exposure condition should be air entrained and only given a broom-textured finish. Generally, air content will be based upon the maximum aggregate size in the mixture. Proper placement, consolidation, finishing, and curing will yield a durable exterior concrete surface.

### 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 301, "Specifications for Structural Concrete (ACI 301-16)," American Concrete Institute, Farmington Hills, MI, 2016, 68 pp.
3. Bimel, C., "Is Delamination Really a Mystery?" *Concrete International*, V. 20, No. 1, Jan. 1998, pp. 29-34.
4. Lankard, D.R., "Air Entrainment and Delaminations," *Concrete International*, V. 26, No. 11, Nov. 2004, pp. 21-30.
5. "CIP 20 – Delamination of Troweled Concrete Surfaces," National Ready Mixed Concrete Association, Silver Spring, MD, 2004, 2 pp.
6. Tarr, S., "Concrete Q & A: Floors for Freezer Facilities," *Concrete International*, V. 29, No. 7, July 2007, pp. 87-88.

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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 [rex.donahey@concrete.org](mailto:rex.donahey@concrete.org).