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THE ASHFORD FORMULA AND AIR ENTRAINMENT

Concrete is often chemically entrained with tiny air bubbles to protect it from damage caused by freeze/thaw cycles in cold climates. These microscopic voids allow "room" for the water in freshly placed concrete to expand and contract during such cycles. This procedure also protects hardened concrete when it is exposed to moisture and subsequent freezing temperatures, or when it is treated with deicing agents.

However, entrained air is not always used in freeze/thaw conditions. Smaller percentages of entrained air can also reduce bleeding and segregation, and are recommended when they improve the finish of concrete surfaces not exposed to freezing. Air entrainment also improves the ability of the concrete to be pumped.

Air entrainment is accomplished by means of admixtures that contain vinsol resin and/or multi-component organic materials. At a constant water-cement ratio, air entrainment usually reduces the compressive strength of concrete. The lower strength is caused by additional voids in the cement matrix. It is however possible to compensate for the lower strength by using less water, thereby increasing the water/cement ratio. Since most air entraining agents are also water reducers, the use of less water is warranted anyway.

Strength reduction from air entrainment will affect richer concrete mixes more dramatically than leaner mixes. Normally, air entrainment will result in a 2% to 6% strength reduction for each one-percent of entrained air. Some newer formulas actually *increase* the strength of concrete.

Typically, concrete exposed to freeze/thaw conditions will require anywhere from 4% to 8% air entrainment, depending primarily on the size of the aggregate. Normal non-air-entrained concrete will have air contents ranging anywhere from 1% to 3%, again depending on the size of the aggregate.

The most effective air entraining admixtures will produce air bubbles that are evenly distributed throughout the cement paste. If bubbles coalesce, they cause large voids in the matrix that can result in fractures. Often, bubbles can congregate right at the point of interface between the paste and the coarse aggregate, resulting in poor adhesion and strength. This is why uniform distribution of air bubbles is so critical. The bubbles should also have the thickest possible walls, and be of uniform size for best results.

Often, we are asked if there are any problems using The Ashford Formula with concrete that has been air entrained. The answer is that The Ashford Formula will seal, harden, and dustproof any concrete surface that has been made with standard-grade portland cement. The Ashford Formula reacts with the alkalis in cement to achieve these results through densification. The Ashford Formula can only react with the cementitious matrix that surrounds the bubbles, not with the air in the bubbles themselves.

While The Ashford Formula is an excellent product for curing, sealing, hardening, and dust proofing, it cannot overcome some of the common finishing deficiencies often related to the use of air-entrained concrete in floors. Because air entrained concrete slows the movement of bleed water, a floor surface can appear ready for final troweling, even though not all the bleed water has risen to the surface. This can cause the top veneer of the concrete to blister, and even delaminate.

The better cohesiveness of air-entrained concrete may also make the surface sticky and more difficult to finish. In such cases, improper finishing tools can tear the surface, leaving a rough or unattractive surface. A magnesium bull float is normally the best tool in such instances. Reduced bleeding can also accelerate drying, causing plastic shrinkage cracks, unless fog sprays or evaporation retardants are used, or unless curing agents or coverings are quickly applied.

Sources:

1. Concrete Construction, April 1988, pp. 412-414. "Better Bubbles."
2. Concrete Construction March 1990, pp. 279-286 "A Contractor's Guide to Air Entraining and Chemical Admixtures."
3. American Concrete Institute. Guide for Concrete Floor and Slab Construction. Publication ACI 302.1R-89. Pg. 11, 15, 16.