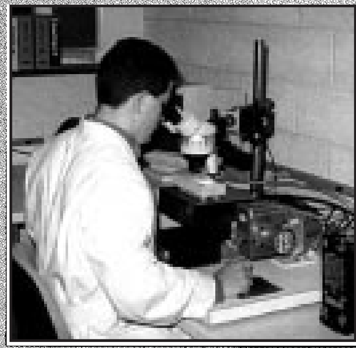
It's Only Air—But It's Really Important!

Whenever concrete strength and/or durability are in question, concrete technologists include a look at the air-void system in their search for answers. Construction Technology Laboratories, Inc. (CTL) petrographers use a sophisticated computerized linear traverse device to provide the accurate and reliable data needed to calculate the parameters of the air-void system.



A CTL petrographer utilizes a computerized linear traverse/modified point count system to electronically record and measure air content and other air-void system parameters.

Air Bubbles are Important

Tiny, microscopical air voids are intentionally produced in modern concrete, especially that destined for outside use in climates characterized by cyclic freezing and thawing. The concrete is said to be "air-entrained"(AE). Highways, sidewalks, streets, retaining walls, and other structures exposed to weather should be air-entrained. An improper amount of air (or voids) in concrete can be a major cause of deterioration. With the correct amount of air (typically 5% to 7%) in concrete, freeze-thaw durability is significantly enhanced. Air voids affect the relative strength of concrete as well as its freeze-thaw durability.

It's a Delicate Balance

The presence of too much air may reduce concrete strength below acceptable levels. And too much water also diminishes the concrete's strength, causing shrinkage cracking and increasing permeability to moisture. Air-entraining agents (organic chemicals) are added to preserve or stabilize the air voids generated during the concrete mixing process. In effect, these AE admixtures form the air into millions of tiny, stable bubbles, which help lubricate the fresh mix. This makes the mix easier to place without addition of water, thus reducing the water-cement ratio and the permeability.

The Measurement Process is Accurate

Several measurements are used to characterize the nature of the air-void system in AE and non-AE concrete.

The concrete specimen used for this work is a polished saw-cut cross-section (see photo). Under the binocular microscope of the device, air voids generally appear as circular depressions. It is the size, shape, distribution, and number of bubbles (or voids) that the petrographer studies when conducting an air system evaluation. The petrographer also measures the space between the voids and calculates the number of voids per inch. The data gathered can then be used to compute the parameters of the air-void system.

Total air content, specific surface, and void-spacing factor are the most critical parameters on which to base an assessment of the adequacy of an air-void system for frost protection. The calculations include volume of air in void-size classes.

For more information on CTL's linear traverse/modified point count capabilities and the parameters used to characterize the air-void system in hardened concrete, contact David B. Vollmer, petrographer, at (708) 965-7500, ext. 235.

Editor's Note:

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Good Construction Practices Include Curing

After placing and consolidating air-entrained concrete, little if any free water (bleed water) will appear on the surface. But, a waiting period for the concrete to firm up is still required. At the proper time, a skilled craftsman should complete finishing operations without delay and then immediately begin moist-curing to ensure continued strength gain and adequate durability. The portion of a concrete slab most vulnerable to rapid drying is also the portion where strength and durability are most needed—the upper one-quarter in. (6 mm). Lack of curing permits rapid drying, leaving the top surface less durable and with a lower strength than the rest of the slab. Moist curing can be achieved satisfactorily by covering the surface for 7 days with a 4-mil-thick polyethylene plastic sheet, or by spraying the surface with a good liquid membrane-forming curing compound.

Air Drying in the Fall

A period of air drying of new concrete before the first freeze will increase the concrete's resistance to surface scaling. Slabs placed in the spring and summer normally have sufficient drying time before exposure to freezing temperatures. Slabs placed in fall, however, do not always dry out enough before freezing weather arrives and the use of deicers begins. Adequate drying time is a frequent oversight for fall work cured by membrane-forming compounds. Use of curing compounds during fall construction should be prohibited and replaced by other methods of moist curing. If freezing weather or deicer application will occur within 30 days of the end of the moist curing period, the slab may be given a breathable surface treatment (sealer) to protect the surface against penetration of water and deicing chemicals.

Surface Protection

One of the oldest proven techniques for surface protection is to apply linseed oil. A linseed oil treatment normally consists of two applications of commercial grade boiled linseed oil