Warehouse Floor Field Test: Second Update

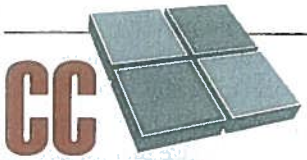
At the 30-day mark, the floor begins to show signs of curling

This is the second in a series of articles about our warehouse floor field test. The purpose of the study is to find economical ways to reduce curling in warehouse floors and to study the rate of moisture loss in concrete after placement. The first article appeared in the February 2009 issue of CC, where the project and its purpose were announced. Now more than three months after placement, two measurements of the floor surface were completed using a D-Meter and a 3-D laser scanner; one measurement the morning after placement and the other at 30 days.

The warehouse is located in the Chicago area and is a development property owned by Scurto Cement, Gilbert, Ill., along with a group of investors. After eight different concrete mixes were placed Feb. 10–12, the temperature in the building, as well as the slab temperature, has remained at approximately 50° F with 60% to 75% relative humidity. Construction activity at the site has been minimal since the installation and the floor is clear and open.

Mixes

There are many things that occur on a jobsite that affect results, and the field test experienced some things that weren't considered. Placed in a winter climate, it turned out on the first day there was an amount of ice in the aggregate that raised the water/cement (w/c) ratio of the concrete by the time it arrived on the jobsite (the w/c ratio was still considered to be low). There were temperature variations between loads as well, temperatures typically being higher with the first loads of the day.



CC Field Test

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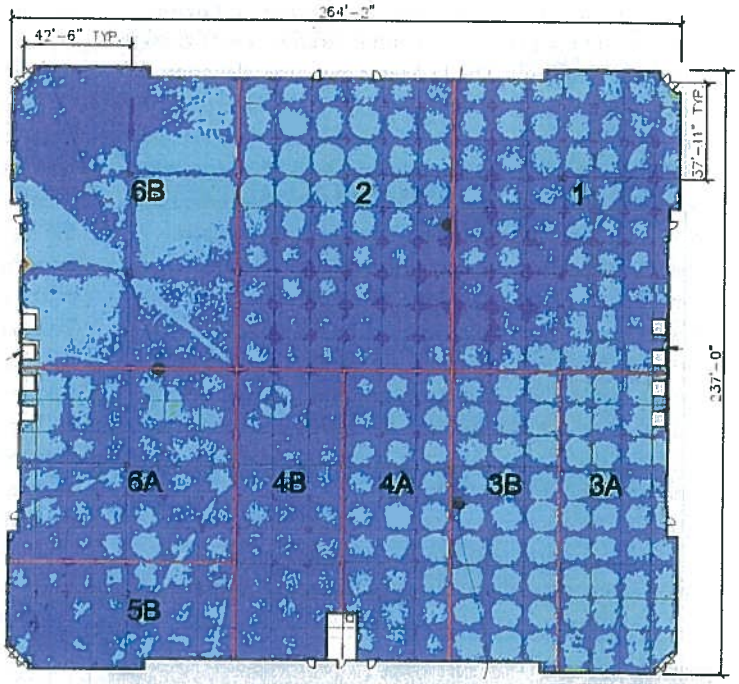

The 3-D laser scan shown here is of the entire 60,000-square-foot floor. The colors represent elevation differences adjusted for the original finish elevations of the floor. Blue is the base elevation, light blue colored areas are ⅛ -inch below base elevation (centers of panels have dropped in elevation), and dark blue represents locations where the elevation is higher than the baseline.

PHOTO: SEC GROUP

The goal for the steering committee was to install one mix that was regarded to be typical around the country. Another mix would represent an affordable, reasonably graded aggregate mix with less water and polycarboxylate superplasticizers. The other mixes represent variations of this mix. The warehouse floor is being monitored for the effect of calcium chloride and nonchloride accelerators, macrofibers of differing dosages versus microfibers, and differing amounts of top-sized aggregate. The study will focus on relative differences between the mixes.

Measuring curl

All slabs curl; it's the result of different volume changes between the bottom and top of a slab. There are several factors that cause variations in the amount of curl over time: the concrete mix, ambient conditions, curing (or noncuring), water added on the jobsite, the inclusion of vapor barriers, and subgrade conditions.

The surface of the floor was profiled with the D-Meter and the 3-D laser scanner on the morning after each of the three placements to document flatness and levelness achieved in the placing and finishing process. A second profile

30 days later pinpoints changes from initial measurements. These measurements to detect curling will be taken every six months for a two-year period to study relative differences between concrete mixes over time.

Two technologies are being used to profile the surface: a D-Meter manufactured by the Allen Face Co., Wilmington, N.C.; and a 3-D laser scanner manufactured by Leica Geosystems, San Ramon, Calif. The D-Meter measures elevation differences as little as 0.001 inches, while the 3-D laser scanner measures to within 3 mm (⅛ inch or 0.125 inch). In the 3-D laser scan image shown on the previous page, the blue color indicates base elevation, light blue in the center of many of the panels indicates a drop in elevation of approximately ⅛ inches, and the dark blue at some panel intersections indicates an elevation rise of ⅛ inches. Jerry Holland, director of design services for Structural Services Inc., Richardson, Texas, says this is typical panel behavior. "As the edges of panels begin to curl the weight becomes supported by the center of the panel and the elevation decreases a little bit."

Surface finish and slab drying

The research project will evaluate the effect of concrete surface finish on slab drying. Conventional wisdom has been that a concrete surface plays an important role in limiting the escape of moisture from within the slab and therefore affects drying times of slabs. A hard-troweled, burnished surface, or a curing compound are thought to retain moisture and therefore lengthen the time required for internal relative humidity to drop to an acceptable level for installation of coatings or adhered floor coverings. Some preliminary laboratory studies support this idea.

However, it is not known if this effect is significant in real-world concrete slabs. The permeance and properties of the bulk concrete may be more important than the permeance of the thin, near surface region. To evaluate this concept, a 200-square-foot area of the floor was placed with a "typical" commercial floor slab mix. Concrete in this area was bullfloated and then given several surface treatments in different areas:

Mix for slab drying study	
Agg: State = 11	1740 lbs.
Sand	1550 lbs.
Cement	517 lbs.
Water	274 lbs.
Air	(none)
NCA	14 oz/C lbs.
Midrange	6 oz.

- Lightly steel troweled by hand, plastic sheet cured three days
- Lightly steel troweled by hand, ASTM C309 membrane forming curing compound
- Lightly steel troweled by hand, sodium silicate sprayed on surface
- Lightly steel troweled by hand, broomed, plastic sheet cured three days
- Burnished, hard troweled finish by ride-on machine, plastic sheet cured three days
- Burnished area shotblasted to ICRI CSP3
- Hand-troweled area shotblasted to ICRI CSP3

Relative humidity probes have been installed at several depths—½, 1, 2, and 4 inches—in each area. Humidity data are being recorded every 10 minutes to create moisture profiles from top to bottom of the slab as each area dries. The field data will be compared to mathematical models of drying rates based on concrete composition and ambient environmental conditions. In addition, selected areas of the main floor with different mixes will be checked periodically for moisture gradients using similar methods. This work is being performed by Howard Kanare, Matt D'Ambrosia, and Mike Klaric of CTLGroup.

A work in progress

Several articles will be written as information becomes available from the study. The next time the slab surface will be profiled will be in August. More information will become available when summer temperatures cause the floor to dry out more. In addition, CC will feature exclusive material on our Web site, including videos, slideshows, and more. Check the site often for updates. CC