Slaying the Curling Dragon

Careful planning, optimized mix design, attention to detail, and first-rate execution produce an outstanding floor slab

By Chad S. White and William S. Phelan

Installation of interior slabs on grade for large distribution centers can be both simple and complex: simple in that slabs are large, open areas, flat and generally free of obstructions; complex in the difficulty of maintaining an aggressive schedule, controlling the placing environment, and ensuring consistency in materials and workmanship. Through careful planning, communication, and attention to detail, the project team for the new Ace Hardware Distribution Facility in Loxley, Ala., installed a high-quality slab at a blistering pace.

This 800,000-square-foot project had a 6-inch thick slab, and a pinwheel column design with square columns and round dowels at the construction joints. Bays are 54x54 feet with a 13.5-foot control joint spacing. Around docks where high traffic was expected, the slabs were reinforced to minimize crack widths and curling.

Planning, planning, planning

The key requirements for all industrial floors subjected to vehicular traffic are a satisfactory surface profile of F_F35/F_L30 or higher, a dense smooth finish, and minimal cracking and curling. Butler Construction selected W.L. Contracting to install the warehouse floors based on their proven ability to produce such a floor and the previous successful joint efforts that these companies have enjoyed. Once the design-build team was assembled, numerous discussions were held to determine the owner's expectations, to review the placement schedule and mix design, and to identify potential problems. These discussions helped to identify several areas of concern that were then addressed prior to installation of the floor slabs. One of the owner's main concerns was to get high performance from the floors for many years. This meant a dense, burnished troweled floor with high abrasion resistance. It also meant that the floor would have to have minimal cracking and curling during its service life.

To satisfy the owner's requirements, Butler Construction and W.L. Contracting focused on several key items:

- *Mix design:* The mix design was optimized to achieve a low water content and a high coarse aggregate content. The combined aggregate grada-

This distribution center got a high-quality slab through meticulous planning and execution.

A year later, the floor is free of cracking and curling.

tion was modified to conform to ACI 302 recommendations, and a high-range water reducer was used for ease of placement. At the owner's request, synthetic fibers were added to minimize plastic shrinkage cracking.

■ *Placing environment:* The project team agreed that all exposed slabs would be protected in a controlled environment, under a watertight roof with the air quality monitored carefully.

■ *Curling:* Butler and W.L. Contracting believe that over the life of a building, curling has a great impact on the durability and usefulness of a warehouse floor. To focus the construction team's commitment to minimize or eliminate this problem, Butler and W.L. Contracting took the novel approach of specifying rigid requirements for flatness and levelness both initially and after one year: a maximum allowable elevation difference of $^{3}/_{16}$ inch between construction/control joints and the center of the panel.

■ *High-traffic areas:* Following discussions with the owner and review of past projects, the construction team decided to reinforce the shipping and receiving dock areas to further minimize cracking and curling in these high-use areas. Number 4 reinforcing bars were placed at 18 inches on center longitudinally in these areas, with #4 tie bars at 4 inches on center in the transverse direction.

The thorough planning and constant communication between the members of the construction team resulted in no significant changes being made to the schedule, specifications, or the selected means and methods of slab placing and finishing during the construction phase of the project.

Building the big box

Subbase preparation and placing of slab formwork started in late January 2000 as portions of the building were enclosed and the base achieved the optimum moisture content. A densely graded base material was leveled using a laser-automated grader and a bulldozer working in tandem. The surface was then carefully compacted so that a fully loaded concrete truck would not depress the surface more than $^{1}/_{2}$ inch. We identified and removed wet or soft areas of the base to ensure a uniform dry base ready for concrete. The base was monitored constantly during concrete placing operations to insure that no rutting occurred, which could cause slab restraint and then cracking.

Prior to major slab placements, the contractor poured a test slab in a noncritical area. This was used to confirm that we had the proper mix design, slab placing, finishing and curing techniques, consistency of materials, and coordination between suppliers, testing laboratories, and the concrete contractor. The construction team was careful to ensure that the test pour was representative of the major slab placements to follow. Production rates, techniques, and equipment used on the test pour were the same as planned for the major slabs.

Slabs were placed using a laser screed at production rates of approximately 120 cubic yards per hour. Slabs

High-performance mix design

Cement	564 pounds/yard^3
Fine aggregate	1320 pounds/yard^3
Coarse aggregate (#467)	1880 pounds/yard^3
Water	277 pounds/yard^3
High-range water reducer	39 ounces/yard^3
Synthetic fibers	1.5 pounds/yard^3
Initial slump	2 to 3 inches
Slump after HRWR	6 inches
W-c ratio	0.48

were pan floated and finished with ride-on trowel machines. Control joints were cut with early entry Soff-Cut saws to minimize cracking, and the slabs were wet cured for a full seven days, then sealed with Diamond Hard. This is a liquid sealer and densifier that is scrubbed into the surface. It is not a film-forming sealer so no maintenance is required. It makes getting tire marks off much easier and provided the owner with the desired shiny surface without the maintenance. Slab placements averaged 43,000 square feet daily, and there were eight placements of 63,000 square feet. The floor flatness and levelness measured approximately F_F60/F_L40.

One-year review

Representatives of Ace Hardware, Butler Construction, and W.L. Contracting inspected the warehouse floors after one year. The floors were in excellent condition with no cracking or curling detected over the entire 800,000 square feet. Based on these results, it is apparent that careful planning, optimized mix design, attention to detail, and first-rate execution can produce an outstanding work platform for the life of the facility. An owner can achieve long-term success with an industrial floor by the proper selection of the concrete team, state-of-the-art floor design, detailed planning, and the installation of the complete floor system.

Chad S. White is president of W.L. Conctracting, and William S. Phelan is senior vice president of Euclid Chemical Co. Phelan will conduct a seminar at World of Concrete 2002 entitled "How to Plan Properly for Successful Floors," covering many of the ideas addressed in this article.

Construction team

Design-Build Contractor: Butler Construction, Kansas City, Mo.

Architect: Warren, Nees, Bost Architects, Kansas City, Mo.

Engineer: Johnston & Birkholder Assoc., Kansas City, Mo.

Concrete Contractor: W.L. Contracting, Arlington, Texas

Ready-Mix Producer: Sherman Industries, Mobile, Ala.

Admixtures and Floor Sealer: Euclid Chemical Company, Cleveland, Ohio. For infomation: 261-531-9222, www.euclidchemical.com or circle **2** on the reader service card.

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