Constructing *High-Quality* Industrial Floors

Controlling variables and watching the details are key.

By Joe Nasvik

Building a reputation for installing long-lasting, hard-wearing, maintenance-free floors means going the extra mile. The Fricks Company, Fort Worth, is known across North America for just that kind of work: dense, durable concrete floors built using aggregate surface hardeners, shrinkage-compensating concrete, de-watered toppings, and superior joint and slab details that outperform conventional concrete floor slabs.

Brad and Greg Fricks, brothers and co-owners of the company founded by their father Terry Fricks, are of one mind on the subject of quality, never flinching from removing and replacing work that doesn't meet their own expectations. Spending many hours on jobsites with their crews, the brothers often revisit installations to assess performance and learn how to improve their process. More than 75% of their business is repeat work; clients are willing to pay for quality because they know how the floors perform over time. (To read an interview with the Frickses, see Contractors to Watch, December 2005, p. 90.)

- *The goals for such high-quality floors include:*
- *Few to no cracks over time*
- *Minimal curling*
- *Flat transitions over construction joints*
- *Meeting or exceeding flatness requirements between joints*
- *Joints that hold up over time to excessive forklift traffic*

There isn't a better way to tell when its time to start the finishing operation than to step on the slab and see how deep footprints are. They should be 1/8 to ¼ inch.

Taking responsibility

The successful completion of one step provides the opportunity for the successful completion of the next step. Careful planning, delegation, and accountability ensure that all conditions are right for good floor construction. Some areas of concern include the concrete mix design, subgrade conditions, the building enclosure, ambient conditions, other trade work, joint layout, pour sequence, construction joint locations, final forklift traffic patterns, and curing. Greg says they choose not to be involved in "place-and-finish" contracts where they can't have responsibility for all the factors that affect the outcome of their product. "It leads to finger pointing when things don't go right," he says. "The goal for us is to cause every party to do their part to provide the conditions needed for quality work."

Normally the owner's representatives define responsibility by providing specifications and supervision on a jobsite. But the Frickses have the knowledge to be involved in the decisions made affecting their work. The goal isn't to be adversarial, but rather to be a partner in determining the end result.

Important pre-construction issues

The first important step in achieving high-quality floors is the pre-slab construction meeting. Fricks usually conducts this meeting attended by personnel from the owner's rep, the general contractor, the facility manager, the ready-mix producer's quality control, the testing agency, and any other construction trade that affects the work. Items on the agenda include safety, weather protection, heating or cooling the structure, lighting, protection of the slabs, subgrade conditions and elevation, submittals, mix designs, quality control, testing, joint details, reinforcement, curing, cracks, and curling. This is the perfect opportunity for all parties to lay out their expectations.

Fricks places concrete with a 3-inch slump—lower than most contractors. Laser screeds can place concrete even at 0-inch slump, but the boom must travel more slowly, and two passes may be necessary to get the elevation of the slab right.

Building enclosure. *Brad says that quality work starts by controlling the environment. A building should be enclosed with a waterproof roof. To produce a floor with a highly burnished trowel finish, the goal is a tight building with consistent temperatures. Some owners complain about different color from one day's placement to the next. A constant environment is one way to minimize this.*

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Subgrade preparation. *Though others are usually responsible for placing subgrade, it's a high liability issue. Brad says they always check the subgrade by proof-rolling with a loaded ready-mix truck or a full dump truck. They don't want to see wheel depressions of more than ¼ inch. Soil that "pumps" or ruts must be removed and replaced. The subgrade must also be uniformly dry, and any wet material must be removed and replaced.*

A typical Fricks contract calls for the subgrade to be turned over to them at ±0.10 foot to balance. Balance means the highs fill the lows and the elevation in any given area does not exceed the 0.10 specification. Any excess material is to be removed by others and any additional material needed is supplied by others. Fricks uses lasers to fine grade the subgrade to be at 0 elevation to minus ¼ inch (+0/- ¼ inch) and has at least three slab placement areas prepared at all times to ensure constant daily placements for production.

Concrete mix design. *For the long-term performance of a floor, the mix-design is one of the most important aspects. Fricks is unusual among contractors because it has its own in-house concrete testing facility to develop its own mix designs and conduct tests for shrinkage-compensating concrete mixes. They do this because the long-term performance of a slab reflects on the company's reputation.*

Before a project starts, they collect aggregate samples from the project's ready-mix supplier and develop an optimized aggregate mix. The ideal top size is 1½ inch, when available. Sometimes they truck in aggregates to get the needed or desired aggregate blends. The number of different sizes required to obtain the optimum mix design depends on the type and gradation of the local materials and the number of bins at the producer's plant. Terry Fricks says, "As a result of working all over the country we've gained experience and knowledge in dealing with a large variety of aggregate gradations and types." This experience tells them what will and will not produce a low shrinkage mix. The coarse aggregate in a typical Fricks design accounts for 60% to 65% of the total aggregate content. The water/cement ratio or total water is greatly affected by the local materials, and adjustments are made with the coarse-to-fine aggregate ratio and water-reducing admixture to minimize the total water and shrinkage. Often, at the start of a project, minor adjustments are made to the mix to achieve optimum finishability.

Fricks believes that it's better to start finishing with a walk-behind machine with float shoes. They want to open the surface up as quickly as they can without damaging the surface flatness.

For the Fricks Co., a good relationship with the ready-mix supplier is key. But so is the concept of responsibility for the product. Greg says that they require batch weight tickets to accompany each load of concrete delivered to the jobsite so that they can compare the individual loads with one another. This is the first step in holding the ready-mix producer accountable. Brad adds that they require concrete with a 3½-inch slump ±½ inch

Fricks' concrete floor construction sequence

- *Pre-lab construction meeting is held.*
- *Subgrade is prepared.*
- *Forms are set to proper elevation using an optical level.*
- *Concrete is placed, often two or three trucks at a time.*
- *Concrete is screeded using a laser screed; because of low slump, two passes are often required.*
- *Edges are vibrated to consolidate concrete around diamond dowels and previous work.*
- *Concrete is bull-floated with an 8-foot channel radius float.*
- *Edges are struck off and hand-floated.*
- *First floating operation uses walk-behind trowels.*
- *Edges are re-struck and hand floated again.*
- *Slab is re-straightened with a 16-foot-long highway straightedge.*
- *Second floating operation uses walk-behind trowels.*
- *Edges are re-struck and hand floated again.*
- *Slab is re-straightened with a highway straightedge.*
- *Riding trowel performs first pan floating operation.*
- *Edges are re-struck and hand floated again.*
- *If high F-numbers are required, slab is re-straightened with highway straightedge.*
- *Second and third passes are made with pan floats, re-striking and re-straightening the slab edges each time.*
- *With combination blades on riding trowels, finishers complete three to six passes, depending on mix design, ambient temperature, and concrete temperature.*
- *Edges are hand troweled.*
- *Using finish blades on riding trowel, finishers complete three to six passes, depending on mix design, ambient temperature, and concrete temperature.*
- *Control joints are sawed using early-entry saw as soon as edges don't ravel.*
- *Floor flatness is checked, crossing control and construction joints.*
- *Wet curing begins.*

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delivered to the jobsite. Loads higher than 4 inches are rejected. "A good supplier can supply concrete consistently within ±½ inch of the target," Brad says. They also require the supplier to serve them from only one plant, with consistent delivery times and mixing times. To accomplish these goals they ask that the supplier have a quality control person on the jobsite when concrete is being placed to call for consistency adjustments.

Using an aluminum straight-edge, finishers re-straighten the edges several times during the finishing process to ensure that they remain flat across construction joints.

Labor force and supervision. *The team that installs the concrete floors is central to producing high-quality work. Fricks moves its entire labor force from one project to another and has very little turnover. Workers are trained to perform to the expected level of quality and to take good care of their equipment.*

Control joints. *Joints are one of the most important considerations for a floor because slab failures usually start there. Fricks makes suggestions to the owner on the details in areas where cracks are likely, such as inside corners and around loading docks. When using conventional concrete they use early-entry saws for control cutting, starting as soon as there is no raveling of the joint.*

Construction joints. *Fricks bevels the top of its bulkheads so that the edge facing the concrete guides the finishing operations. Diamond dowel joints are the preferred method of providing load transfer. Workers vibrate construction joints during concrete placement to ensure proper consolidation. Fricks' workers take many added steps to re-straightening the slab edges to ensure that transitions to other placements are flat and even.*

Curing. *Wet-curing is the best method, and it starts immediately after the control joints are cut. Workers spray water over the slab and lay down curing covers for seven days. Floors are checked each day for dry surfaces, which are then re-wet and re-covered. Curing covers prevent atmospheric carbon dioxide from reacting with calcium salts from the slab during curing, which can lead to efflorescence and a stained appearance.*

Production issues. *Placing low-slump concrete slows down production. With 5-inch slump concrete, a contractor could typically place 120 to 180 cubic yards per hour. Fricks is typically placing at about 80 cubic yards per hour-making an average day on a large project to be 20,000 to 25,000 square feet. Their conviction is that it's better to place the same amount of footage each day rather than to go for record placements one day with much lower production on others. Daily consistency helps build a superior floor.*

Finishing. *One part of the process that separates Fricks from many others is the finishing sequence. When the depth of a finisher's footprint is 1/8 inch to ¼ inch, they start the finishing process using float shoes on walk-behind trowels. The object is to open the slab up as soon as possible with minimal damage to surface flatness. Just behind the trowel a highway straight-edge (also called a "bump cutter") is used to re-flatten the floor. Finishers use 3-foot metal straightedges at all edges after each machine pass to eliminate any elevation differences between slabs. There is at least one pass with a walk-behind trowel before the first use of pan floats on a riding trowel. Fricks contends that using a walk-behind trowel with float shoes before pan floats properly consolidates the materials at the surface and minimizes craze-cracking.*

The first pass with a ride-on trowel with pan floats occurs after one or two passes with walk-behind trowels. Great care is taken to maintain flat edges.

Fricks also uses a highway straightedge to re-straighten floor surfaces after the first trowel floating operations.

Quality and consistency

The Fricks Company focuses on consistency in materials, ambient conditions, and placing-finishing steps in order to achieve high-quality results. Its goal is to exceed the owner's expectations over the life of the floors. Quality means strong, very dense concrete, few to no cracks, very little curling, and flat finishes that include construction joints that produce no vibration when forklifts pass over.

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