Sell shrinkage-compensating concrete on its merits

By **Terry J. Fricks**

Expansive agent in cement minimizes drying-shrinkage cracking, allowing larger joint-free pours

Many contractors and their suppliers have become frustrated competing in a marketplace that seems committed to the low bidder. But if two products are equivalent, it's logical for the buyer to select the least expensive product. However, when a product is superior, the seller must show the buyer how the product surpasses the others.

There's a difference

Conventional concrete begins to shrink as it dries. This shrinkage produces internal tensile stresses that are relieved by cracking. In shrinkage-compensating concrete, there is an expansive agent (the most common is anhydrous calcium sulfoaluminate) in the standard portland cement compounds. This agent creates expansion, which results in compressive forces in the concrete that slightly more than offset the tensile stresses. While this process can greatly reduce drying-shrinkage cracking, it is not designed to eliminate settlement, structural, or plastic shrinkage cracking.

The most obvious benefit of shrinkage-compensating concrete is the possibility of larger pours while minimizing drying-shrinkage cracking. Additional benefits include: reduced permeability, improved resistance to sulfates, less curling, and more durability. Since the companies that produce shrinkage-compensating cement have managed to create a product that is sufficiently different from "conventional" cement, they can actually sell the merits of their product rather than simply bid alongside other cement producers. Similarly, contractors that develop expertise in working with shrinkage-compensating concrete can differentiate themselves from potential competitors who have not acquired those skills.

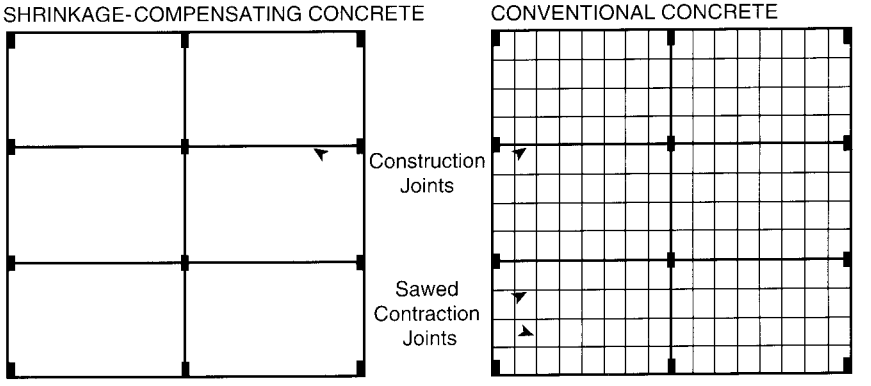

Figure 1. *Each slab is 80x120 feet or 9,600 square feet (left). The total floor slab is 57,600 square feet. Each 9,600-square-foot panel is divided into 15x20-foot panels by sawed contraction joints (right). Thus, this 57,600-square-foot floor requires 5,520 lineal feet of contraction joints. These joints may be eliminated with the use of expansive cement.*

Special niches

The special characteristics of shrinkage-compensating concrete have proven to be especially valuable in a number of applications, some of which are:

- Bridge decks
- Parking garages
- Treatment plants
- Industrial floor slabs
- Airport taxiways and runways
- Beneath ice rinks and stadiums
- Exhibit halls
- Containment vessels

There are many other applications for shrinkage-compensating concrete that draw upon the product's special characteristics. The ability to place large joint-free areas is not only convenient for the contractor; it can represent a significant advantage to the owner in many applications. Fewer joints means less formwork and edge finishing, and improved productivity. Depending upon the application, it also can represent a tremendous decrease in joint maintenance (slab on grade) or leakage (containment vessel) for the owner. The number of applications for this

product is limited only by your imagination and creativity.

Where concrete project mobilization costs are high, contractors can use shrinkage-compensating concrete to decrease the number of placements from three or four to only one. The high cost of setup and then cleanup of pumps and other equipment is paid once. Projects in remote locations, on tight schedules, or behind budget should consider the effective and economical use of shrinkage-compensating concrete.

Contractor beware

If shrinkage-compensating concrete was the best product for all applications, everyone would use it for everything. The following comments presume that the reader is familiar with the placing and finishing of "conventional" concrete, and so will focus primarily on how shrinkage-compensating concrete might be different.

Placement Size. Shrinkage-compensating slabs on grade of 8,000 to 10,000 square feet without joints are common (see Figure 1). One of the most important considerations is the length-to-width ratio of the placement. Although ACI suggests that length-to-width ratios of up to 3:1 are possible, a more conservative 1.5:1 is suggested.

Testing. Testing laboratories can study samples of various mix designs to help predict how the concrete will perform. Two tests for expansive properties are ASTM C 806 (mortar test) and ASTM C 878 (concrete test). If a contractor specializes in a particular kind of placement, uses the same concrete supplier (who uses the same sand, rock, etc.), and places under the same conditions (temperature, humidity, reinforcing, etc.) repeatedly, tests may not be necessary after the first project. If any of the variables change, however, it is strongly recommended that additional testing is done. This is good news and bad news. Experience is worth more when you are dealing with shrinkage-compensating concrete. If you have decided to become an expert at some market segment, you have an advantage over a new competitor entering your arena. On the other hand, until you do gain experience, those same factors work against you.

Expansion. Necessary restrained expansion can be estimated using tables provided in ACI 223. Shrinkage-compensating concrete initially expands, gradually contracting to approximately original dimensions (see Figure 2). As a rule of thumb, many contractors estimate that a reinforced slab will expand approximately ⅜ inch in 100 feet in both length and width. Some allowance must obviously be made for the expansion. A common solution is the use of compressible filler strip between the concrete and any areas of resistance such as walls, beams, columns, etc. Fortunately, the concrete only needs two adjacent sides open for expansion, so the other two (opposite) sides may be adjacent slabs, walls, or other areas of resistance.

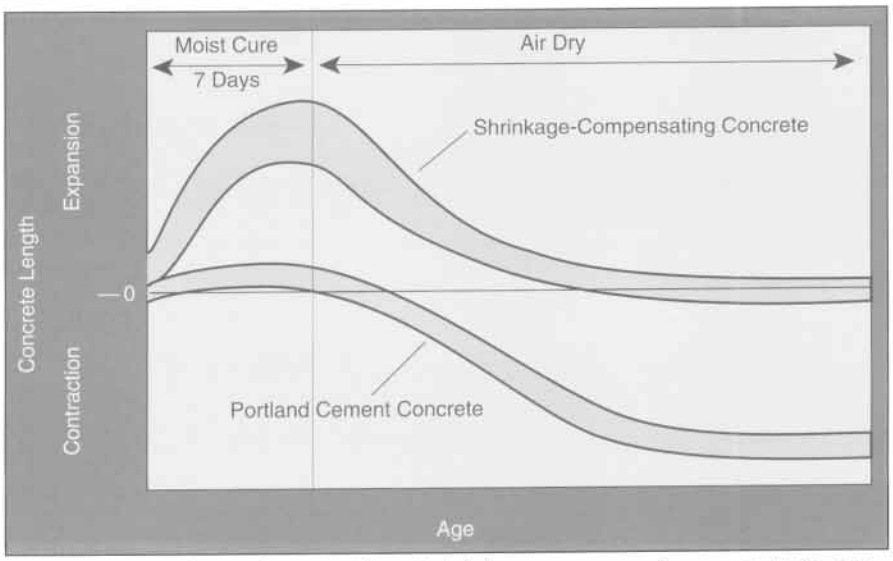

Figure 2. *Expansion and contraction of shrinkage-compensating concrete is compared with portland cement concrete.*

Placement Sequence. If your application is large or complex enough to make multiple placements necessary, it is critical to recognize that expansion takes place for several days and that it is not practical to have two edges expanding into each other. Sufficient compressible material to relieve the problem would leave an unacceptably wide joint after contraction was completed, so the intuitive solution is to plan a placement sequence that allows new placements to take place adjacent to areas that have stopped expanding. It typically takes 7 days for the concrete to stop expanding. This may be unrealistic from a scheduling standpoint. Most contractors don't wait 7 days; however, caution should be used since high restraint from adjacent slabs or excessive reinforcing will induce high compressive stress, but little shrinkage compensation.

Admixtures. Most concretes made with shrinkage-compensating cement require the addition of admixtures such as water reducers. The conservative approach is for the material supplier to confirm the compatibility of the admixture with the cement manufacturer.

Location of reinforcing. In order for the expansive process to work properly, reinforcement must be present to restrain the expansion. The placement of reinforcing steel is always important, but it is even more critical when you are dealing with shrinkage-compensating concrete. For slabs on grade, reinforcing should be in the upper half of the slab, preferably one-third of the depth from the top to offset subgrade friction.

Amount of reinforcing. Good design is a function of both material properties and intended use, but a minimum of 0.15% reinforcement based on cross-sectional area is recommended by ACI 223. Varying the amount of steel reinforcement will affect the expansion and contraction of the concrete.

Placement. A characteristic of shrinkage-compensating concrete is little or no bleedwater. This lack of water allows finishing operations to begin earlier than when using conventional concrete. With a faster setup, care has to be taken to avoid cold joints. If you do not have experience with shrinkage-compensating concrete, anticipate a placement that feels "sticky" and has less apparent slump than normal.

Finishing. A positive characteristic of shrinkage-compensating concrete is how easy it is to finish following initial strike-off and floating. This is a result of having more matrix (cream) on the surface.

Variations. As previously mentioned, shrinkage-compensating concrete is sensitive to variations in such things as mix design, reinforcement, humidity, and temperature. The formation of the stable ettringite crystal structure causes an expansion to occur which results in compressive forces in the concrete. The ettringite crystal formation offsets the natural drying shrinkage of the concrete to give shrinkage-compensating concrete its most notable characteristic, shrinkage compensation. Clearly the chemistry and physics involved are at least slightly more complex than the already intricate processes that are at work in conventional concrete. Variations in the mix or jobsite conditions therefore affect a more intricate process and make the behavior of the concrete more difficult to control.

What it means

Many of your potential competitors will not be ambitious enough to gain the knowledge and experience necessary to consistently deliver a quality product. Thus, contractors who do become proficient with shrinkage-compensating concrete will have the opportunity to develop new ways to use the special properties of the product to better meet the needs of owners. Meeting needs can help you differentiate your company and gain a competitive advantage.

Terry J. Fricks is founder and president of Fricks Floor Systems Inc., Fort Worth, Texas, a contracting firm specializing in industrial concrete floors. He is a member of ACI committees 223, 302, and 360.