A REPRINT FROM THE OCTOBER 2006 ISSUE OF RFID JOURNAL

RFID Cures Concrete

Construction crews that use RFID to test when concrete has cured, or hardened, could complete projects days or weeks ahead of schedule.

By Mary Catherine O'Connor

Oct. 30, 2006-Workplace stress can make people do desperate things. Five years ago, Tim Stallard, a concrete engineer with the Michigan Department of Transportation (MDOT), was so frustrated by the poor performance of a wired temperature sensor he was using to track the hardness of curing concrete that he snagged a wireless indoor-outdoor temperature-monitoring system from his house, buried one of the sensors in a slab of freshly poured concrete and tested how far from the device he could walk before losing the signal. When the signal held for a good 30 feet, he knew he was onto something.

Stallard decided to search for an RFID vendor able to develop a wireless version of the wired sensors used conventionally to track the rate at which concrete cures. "The first few [RFID] companies I called thought I was nuts," Stallard recalls. "But when I called Identec Solutions, vice president of engineering Barry Allen responded by saying, 'Gee, I don't know, maybe it could work.

Allen sent a test kit to Stallard that included some Identec Solutions i-Q tags and a handheld interrogator to program and read the tags. These were battery-powered, came with an integrated temperature sensor and could operate in the ultrahigh-frequency (915 MHz) range. Stallard buried the tags and found that they worked. He could track them individually and take periodic temperature readings. He could even write data directly to the tags, such as assigning tag numbers or noting their location or depth within a slab of concrete.

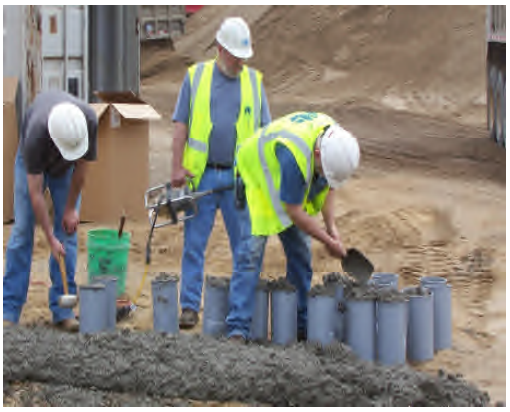
Identec's iQ32T tag

To develop an entire solution for tracking concrete maturity based on the i-Q tags, Identec turned to International Road Dynamics (IRD), a Canadian firm specializing in data-collection software for traffic - and transportation-related applications. The company needed to find a way to detect the concrete's temperature and estimate its strength without having to wait as long as conventional testing methods require.

Construction crews must wait until poured concrete matures-that is, hardens or cures-before they can safely remove the forms holding it in place and move on to the next phase of construction. (Removing forms or other structures used to support curing concrete too early could be dangerous, especially in building construction, when the concrete hasn't hardened enough to support the weight of the structure.) Concrete typically hardens fully in 28 days, but depending on the temperature and volume of the concrete poured, it can cure much faster. By determining the poured concrete's maturity as quickly as possible, construction crews can shave hours of waiting time off each day's workload, enabling them to complete projects days, or even weeks, ahead of schedule.

Engineer checking the hardness of the concrete by reading the RFID tag from his truck.

The wired temperature-sensor test Stallard was using to predict the maturity of poured concrete tracks the temperature inside a section of poured concrete, using an algorithm that compares the temperature with the amount of time it has been curing to estimate the maximum pounds of force per square inch it can withstand. But Stallard says the wired temperature monitors perform inconsistently because if two sensor wires touch each other, they short out and throw off the readings. "I really got fed up with this," he says. He also wanted a solution that would automate the mathematical step of determining the concrete's hardness.



Construction crew making Test Cylinders

A compressive strength test more accurately predicts the maturity of poured concrete, but this can take up to several weeks to produce results. To perform the test, employees must pour samples of the concrete into test cylinders at the same time the concrete is poured. During the curing process, an instrument measures the units of pressure per square inch of concrete required to break the sample. Large areas of concrete can cure more quickly than the small samples used to test hardness, because the test cylinders are not exposed to the same temperatures as the poured slab.

IRD developed a Windows-based software application that pulls temperature data from an interrogator reading the concrete-embedded tags. The data is put into a maturity equation that compares the temperature readings of the poured concrete with the results of two sample cylinders, which can be tested in a lab prior to construction. The IRD software runs on the Pocket PC Windows operating system and can also run on a Laptop computer.

IRD sells the RFID concrete maturity-monitoring system primarily through WAKE, Inc., a Sturgis, Michigan-based technology integrator, and also through a small network of resellers, which serve the construction industry. WAKE markets the monitoring system under the HardTrack brand name.

In 2003, Stallard received WAKE's first RFID concrete maturity-testing package, consisting of the IRD software, a handheld computer, a set of Identec's i-Q active tags and a mobile RFID interrogator that fits into a handheld PC card slot. The Michigan DOT now uses the system for road-construction projects with a short timeline-for example, if a busy stretch of highway needs to be repaved over a weekend or in just one night. It enables the paving crew to reopen the closed lanes faster, alleviating traffic backups and bringing normal traffic flow back to local business corridors. A handful of other states' departments of transportation have followed Michigan's lead by purchasing the RFID system to shorten project times through better prediction of the concrete's maturity.

The Port Authority of New York and New Jersey - which oversees construction and maintenance of all major airports, bridges, tunnels and seaports between New Jersey and New York City, and also owns the World Trade Center property-has tested the RFID system in bridge reconstruction, as well as on a runway re-surfacing at Newark Airport. To test the accuracy of the RFID system during the runway repaving project, the Port Authority made a number of test cylinders for compression tests, burying one of the test cylinders into the large slab of concrete as it was poured into the section of runway being repaved.

When the IRD software indicated the concrete inside the buried cylinder had reached a desired level of strength, employees pulled the cylinder out from the slab and performed a compression strength test on it. The test proved that the RFID system accurately predicted the concrete's cure rate. The elevated temperature inside the slab made the buried cylinder cure in approximately six hours. The same mix in the lab-tested samples took many days to harden to the same strength. If the Port Authority had relied solely on the RFID system, it could have re-opened the runway days earlier.

IRD's solution "lets you tie in all the readings from the data logger in the tag, [run the algorithms] and tie that into a spreadsheet you can really get a lot of useful info from," says David Potts, materials engineer with the Port Authority. "The advent of the wireless monitors and the ability to interface with the PC and get all your information [without doing the equations manually] has really made it easy to use."

But Potts is skeptical that builders will begin relying solely on the RFID system any time soon. "Maturity testing is a fantastic tool," he says. "But the engineering community is very slow to take on new ideas."

Dick Yesh, product manager for WAKE, concurs that many contractors are hesitant to try new technology. "The attitude we get with some crews," he says, "is 'What do you mean, RFID? My dad did it [the conventional] way for 25 years, and it worked just fine.'" To get more building construction crews to use the RFID system, or to rely on it solely, Yesh says more design engineers and architects need to require the use of the testers in building specifications.

Will Hansen, professor of civil engineering at the University of Michigan in Ann Arbor, recently performed a study comparing the use of RFID maturity testers and traditional test cylinders, to determine the maturity of concrete during the construction of a parking structure. The study found that in three sections of poured concrete, the RFID system showed the concrete to have reached the desired level of strength between 22 to 25 hours from the time the tags were embedded in wet concrete, while the field-cured cylinders yielded about the same strength in about 67 hours. "This implies that the contractor can start the next construction step, after 25 hours instead of three days if we were to follow the test cylinders."

The study extrapolated that the cost-savings benefit (through reduced wait time) per pour would be roughly $2,000 if the RFID system were used in combination with a third of the test cylinders typically used in the project. Considering that the system costs from $4,000 to $6,000-depending on whether the customer purchases a handheld to run the software, and how many Identec tags are purchased with the starter kit-a construction crew would begin seeing a return on the system after a couple of similar projects, depending on how many tags were needed for the projects.

One of the screens from the software.

Paul Gausewitz, senior project manager with Materials Testing Consultants, a Michigan testing firm, says his firm recently worked on a parking-structure project in which the client wanted to use both RFID maturity testers and compression-strength test cylinders. "The owner, Spectrum Health, didn't feel comfortable relying on just the maturity meter since it was their first time being involved with that method," Gausewitz explains. "But if we had eliminated all, or some of the test cylinders, which I was comfortable doing, after several placements, comparing the test-cylinder results with the maturity-meter results, would have saved time and expense to the owner."

"We're in the process of educating people and getting the designers and the architects to recommend the maturity testers," says Chip Toth, business manager for Soils &, Structures, another Michigan firm that provides testing and quality-control services for building and road-construction projects. He points to a project in which reliance on an RFID system led to significant time-savings. A crew pouring large concrete forms at a Johnson Controls facility in Battle Creek, Mich., saved a considerable amount of time on a multi-month project.

"Field samples cured in from 10 to 14 days, but the big [non-test] slabs were reaching 4,000 psi [the desired strength] in 3 to 4 days," he says. This saved a total of 70 days during the course of the project. All those days are "like gold," he says, both to the client, because it cuts down on overall construction time, and to the builder, who can book more projects during those gained days.

The author: Mary Catherine O'Connor is Senior Editor of the RFID Journal

For further information, contact: WAKE, Inc.
Sturgis, MI 49091
(800) 588-6393