



intelliRock System Overview

What intelliRock Is:

intelliRock is a concrete maturity and temperature profiling system that helps complete construction projects faster by providing real-time, in-situ concrete strength and temperature data that helps accelerate concrete operations.

A handheld reader: The intelliRock reader is used to communicate with and gather maturity and temperature data from the embedded intelliRock loggers.

Software: The intelliRock software facilitates the transfer of maturity and temperature data from the intelliRock reader to a PC in secure, unalterable electronic files enabling subsequent distribution, documentation and/or analysis.



Figure 1: The intelliRock System

The intelliRock system effectively embeds a sensor directly into fresh concrete, in the closest possible proximity to the concrete whose strength it is estimating. The data provided by the intelliRock sensor allows construction engineers or superintendents to make intelligent, on-site decisions about concrete construction activities such as forms stripping, post-tensioning, saw-cutting, shoring and reshoring, or opening pavement to traffic.

The intelliRock system consists of three components:

A logger: An intelligent sensor that calculates and stores temperature and maturity (strength) within the placement where it is embedded. The heart of the intelliRock system, the logger contains these components:

- ◆ Temperature sensor
- ◆ Microprocessor
- ◆ Battery

These components are encased in polyester resin to provide protection and ensure ruggedness. The concrete in which it is ultimately encased further protects the logger. The logger is approximately the size of a 35 MM film canister.

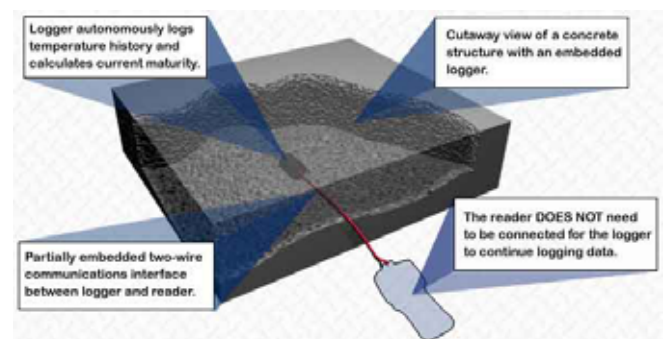


Figure 2: Cutaway view of a concrete structure with embedded intelliRock logger

The real-time strength and temperature data provided by the IntelliRock system is more accurate than data derived from traditional strength estimation technique requiring compressive (destructive) testing of cylinder or beam specimens, a technique that was adopted by the ASTM in 1920 (C31). By embedding the IntelliRock sensor directly into the fresh concrete, the IntelliRock system enables the user to more accurately determine the early-strength estimate of concrete in real time, therefore construction schedules are often streamlined as a result. This in turn reduces related expenses such as forms cycling and reduces man-hours. Having this in-situ unalterable information also helps insure a safer construction environment.

How the IntelliRock System Works

The IntelliRock system utilizes the concrete maturity method, a proven, non-destructive strength estimation technique (ACI¹ and ASTM² standard) to determine in-situ concrete strength. The method has existed since the mid-20th century and accounts for the effects of time and temperature on the strength development of in-place concrete.

Why use the Concrete Maturity Method

Accuracy is the reason to use the concrete maturity method to estimate early strength. The method provides a better representation of in-place concrete strength gain that lab or field-cured specimens, because specimens rarely have the same time-temperature profile as the structure. Strength data is also available anytime, in real-time, often providing necessary strength estimates that allow acceleration of construction schedules. Significant savings of time and money are the result of using the concrete maturity method to:

- Enable earlier form removal
- Optimize post-tensioning
- Perform mix validation
- Improve quality control
- Document time/temperature history

Despite the advantages of the maturity method in estimating concrete strength, its adoption has been slowed by lack of reliable maturity measurement

¹ ACI, Non-destructive- Committee 228, par. 2.6; ACI, Cold Weather- Committee 306, par 6.4 & ACI Committee 318, par. 6.2(d)

² ASTM C1074-98 Standard Practice for Estimating Concrete Strength by the Maturity Method

The Maturity Advantage

"Of all the test methods studied, the maturity method exhibited the lowest variability and most consistent agreement with the generally-accepted standards for concrete testing, including compression cylinder and flexural beams for test ages after 1 day."

Telisak, Carrasquillo and Fowler,
"Early Age Strength of Concrete: A Comparison of Several Nondestructive Test Methods" Center for Transportation Research Report 1198-F, January 1991.

devices tempered for the rugged conditions encountered on construction sites. Prior to the introduction of the IntelliRock system, existing maturity meters consisted of a common temperature sensors embedded in a concrete structure, which in turn was attached to an external collecting device that processed and stored data from the sensor. These external devices or boxes housed the intelligence required to calculate maturity. However, these primitive devices could support only a limited number of temperature probes – a maximum of four, but often, just one – and the connection to the probe for the duration of the curing process was necessary. These sensitive electronic devices were subject to damage from weather and construction accidents, or theft and vandalism. For these reasons, they did not gain favor with contractors, testing labs and owners. The IntelliRock system overcomes these limitations by embedding the intelligence directly into the concrete and the IntelliRock system requires no permanently attached external devices.

IntelliRock System Applications & Uses

Since the introduction of the IntelliRock system in 2002, 26 Departments of Transportation and projects in 31 states have approved or used the system. Numerous case studies document projects ranging from high-rise, sports complexes, bridges, mainline pavement as well as patching and restoration – projects where early concrete strength or temperature profiling are critical. Some of the more notable uses of IntelliRock include the Hanford, Washington nuclear waste disposal facility by the Department of Energy, The Dallas High Five project, the Woodrow Wilson Bridge project, the Washington DC Metro extension project, the Washington DC Metro extension project, the Kennedy International Airport, the University of Oklahoma Memorial Stadium expansion, the Dallas-Ft. Worth airport and the Oakland Bay East span San Francisco approach.



The Maturity Advantage

"The advantage of the maturity concept over casting, transporting, curing, capping, and testing PCC cylinders is logistical. Casting, curing, transporting, capping, and testing PCC cylinders requires considerable time and effort and affords many opportunities for mistakes that most often reduce observed compressive strength."

L.K. Crouch,
"New PCC Maturity Technology: Five Questions,"
Tennessee Concrete, Summer 2003.

The intelliRock system is making an impact on a broad spectrum of concrete projects such as:

- Dallas High Five - Zachry Construction Corporation is on track to earn a large portion of \$11 million in bonus for early completion of the Dallas High Five interchange. Use of the intelliRock system for measuring concrete maturity is one of the reasons why the project is 38 percent completed after only 18 months.



Dallas High Five Project

- Washington Metropolitan Area Transit Authority Blue Line Extension - Using the intelliRock system on this project to optimize concrete workflow operations has been an effective, economical alternative to purchasing additional, expensive traveling forms systems. Furthermore, intelliRock provides the concrete

maturity data and QC/QA information needed to keep the project moving on schedule, even during the cold weather months.



Washington Metro Extension project

- Interstate-40 Bridge reconstruction - On May 26th, 2002, a barge collided with the Interstate 40 Bridge near Webbers Falls, Oklahoma, collapsing multiple spans and killing 14 people. The flow of traffic in both directions of this major east-west national transportation corridor was abruptly severed. State transportation officials predicted a six-month reconstruction schedule; however, the bridge was reopened to traffic after just 47 days of construction. The intelliRock concrete strength measurement system played a major role in the effort, helping the contractor earn a \$1.5 million early completion bonus.



Interstate-40 Bridge Reconstruction project

- Maricopa County 4th Avenue Jail - On this project, McCarthy Building Companies Inc. did not have to wait for seven-day lab results to strip forms and reshores. Thanks to real-time, in-place concrete strength data from the IntelliRock system, McCarthy saved man hours and money by renting less form-work and cycling it faster.



Maricopa County 4th Avenue Jail project

- Marriott Courtyard, downtown Oklahoma City - Flintco Inc. completed this eight-story, 225-room structure using the IntelliRock system to optimize post-tensioning and provide reliable temperature profiling during cold-weather concrete operations, saving one day per pour during the project.



Marriott Courtyard project

- University of Oklahoma Stadium expansion - Flintco Inc. added 8,000 seats and 27 suites to this stadium as part of a \$52 million, 18-month project. At a cost of less than \$5,000, the IntelliRock concrete strength measurement system saved Flintco \$309,000 in man-hour costs.



University of Oklahoma Stadium project

- City of Wichita, Kansas - Using IntelliRock, Pavers Inc. learned that it was obtaining strength for concrete pavement it placed faster than destructive testing methods indicated. As a result, it was able to open pavement sooner for businesses and residents, and recover time lost to weather delays.
- State of Indiana Interstate paving - The IntelliRock system provided Gohmann Asphalt & Construction with a powerful QC/QA tool for a performance-based paving contract. Not only did it provide documentation of compliance with strength criteria, it helped ensure that cold weather concrete placements were within temperature specifications, helping earn the company a significant bonus.



Interstate-65 Paving project



intelliRock System Advantages

The effectiveness of the intelliRock system has been proven on all types of projects, in all types of weather conditions and on projects across the country. It provides users a simplified, reliable means of extracting concrete temperature and early strength information that supports critical construction activity decision-making in real-time and on the job. The advantages of implementing the intelliRock concrete maturity and temperature profiling system are numerous:

1. Streamlined concrete workflow. When concrete is poured, contractors are required to wait for these structures to attain a specified strength before subsequent construction activities are permitted. Historically, contractors wait as long as seven or more days to verify strength through traditional cylinder testing. Because of its mass, concrete in a structure normally gains strength faster than is indicated by companion cylinder testing. Use of the intelliRock system on construction projects allows contractors to know when a structure has reached the necessary strength, often in hours instead of days. **Information provided by the intelliRock system accelerates operations and extends construction calendars** in cooler climates. The benefits of this streamlined workflow include:

- More efficient form cycling
- Reduced form rental expense
- Reduced man-hours
- Optimized post-tensioning

2. Enhanced Quality Control. The intelliRock system provides contractors a way to perform **early on-site concrete mix verification**. When the intelliRock system is used on a construction project, a set of data is first collected to calibrate intelliRock maturity readings to a particular concrete mix's strength gain. Each time this mix is used, the intelliRock system can provide not only strength estimates, but also data about the quality of the mix. Variations in a mix are sometimes

inadvertently introduced at the concrete plant, thus changing the characteristics of the mix and producing less than ideal results. The intelliRock system provides a simple means of verifying mix quality, through casting validation cylinders when concrete is placed. These validation cylinders are tested using a compression machine, and the results compared to strength estimates provided by the intelliRock system. Discrepancies of 10% or higher indicate a problem with the concrete mix or the batching process. The benefits of using intelliRock to verify mix quality include:

- Early detection of mix quality issues
 - Cost avoidance of finding and fixing problems early vs. late
 - A safer work environment
3. Enhanced Quality Assurance. The intelliRock system documents early strength and temperature information for all types of concrete construction activities, such as: form removal, shoring and reshoring, post tensioning, loading structures, saw cutting, picking tilt-up panels, opening pavement to traffic, harvesting pre-cast members, concrete climate control (hot or cold weather), and mass concrete gradients.

intelliRock Benefits

*"intelliRock has helped us go from being behind on the project to ahead of schedule. Being able to measure strength in real time is a major benefit. In five months, our benefit is calculated at **\$175,000**. In warmer weather we have been able to reduce the number of days we wait to remove reshores from 7 days to 2 days."*

Pam Culbertson,
Project Engineer,
Phoenix 4th Ave. Jail,
McCarthy Construction

intelliRock System Benefits

The impact of using the intelliRock system is always quantifiable as a savings of either time or money. A summary of intelliRock benefits, taken directly from intelliRock customer case studies, is presented below:

- Dallas High Five project (Zachry Construction): "The structural segmental work on the project is where some of the most dramatic benefits of maturity occur. The original plans called for cast-in-place segments where it would take an average of 21 days for each segment to be completed. By changing to pre-cast segments using maturity, the intelliRock system indicates the specified 2,500-PSI is achieved in 10-12 hours. It is phenomenal the rate at which they are able to complete work by pre-casting and using intelliRock to tell when we really have strength." Jim Hunt, P.E., Director of Construction, Dallas District, TxDOT.
- Maricopa County 4th Avenue Jail (McCarthy Building Companies): "intelliRock has helped us go from being behind on the project to back on schedule. Being able to measure strength in real time is a major benefit. In five months, our benefit is calculated at **\$175,000**. It gave us reassurance that the concrete was at a safe strength and we weren't putting our people in danger, while at the same time allowing us to gain time on our schedule." Pam Culbertson, Project Engineer with McCarthy Building Companies, Inc.

University of Oklahoma Stadium Expansion (Flintco):

"In the last six months the intelliRock maturity system has saved us **\$309,000** in man-hour costs. In cold weather it has kept us from stripping forms too early". Tom Heffernan, Director of Field Operations, Flintco.

"The intelliRock maturity system has been an asset to the project. During warmer weather, it has benefited the construction schedule by allowing earlier form removal than would have been allowed per destructive testing of laboratory-cured cylinders. In cooler weather, it has provided the assurance that concrete has achieved proper strength prior to form removal." Larry E. Curtis, PE of Kirkpatrick, Forest & Curtis PC.

- Marriott Courtyard (Flintco): "On a cast-in-place job, the quicker you can cycle the forms, the faster the job is going to go. The key to cycling forms is knowing when you reach the required strength. On this job, **I was able to cycle forms in 2 to 3 days even in colder weather** because we had the in-situ information necessary to know how much the element needed protection or how much supplementary heat was needed. Had I waited for cylinder results from the lab, it would have taken five to seven days." Randy Holland, Project Superintendent, Flintco.