PAPWORTHS CONSTRUCTION TESTING EQUIPMENT

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Maturity Measurement – Case Studies

IATECH
Amgen Opus Project - Puerto Rico.

FIATECH's (a R&D consortium) report "*The Use of the Concrete Maturity Method In the Construction of Industrial Facilities: A Case Study*" describes the maturity method & field experience from a field trial conducted by Fluor Corporation during the Amgen Opus Project in Puerto Rico.

Zachry Construction Corporation
High Five Interchange Project - Dallas

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 *intelli*Rock system for measuring concrete maturity is one of the reasons why the project is 38 percent completed after only 18 months.

Flintco, Inc.
Football Stadium, University of Oklahoma

Flintco Inc. is adding 8,000 seats and 27 suites to the University of Oklahoma Memorial Stadium as part of a $52 million, 18-month project. intelliRock has saved Flintco $309,000 in man-hour costs.

Washington Metropolitan Area Transit Auth.
Blue Line Extension Project

Using the *intelli*Rock system on the Washington Metropolitan Area Transit Authority Blue Line Extension project to optimize concrete workflow operations has been an effective, economical alternative to purchasing additional traveling forms. Furthermore, *intelli*Rock provides the concrete maturity data and QC/QA information needed to keep the project moving on schedule, even during the cold weather months.

McCarthy Building Companies, Inc
4th Avenue Jail Project, Phoenix, AZ

On the Maricopa County 4th Avenue Jail 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 *intelli*Rock system, McCarthy saved man-hours and money by renting less form-work and cycling it faster.

Gilbert Central Construction
I40 Bridge Reconstruction, Kiewit, OK

When a barge collided with the Interstate 40 Bridge near Webbers Falls, Oklahoma, collapsing multiple spans, state transportation officials predicted a six-month reconstruction schedule. The intelliRock system played a major role in helping complete construction in just 47 days, which earned the contractor a $1.5 million early completion bonus.

Gohmann Asphalt & Construction, Inc.
I-65 Paving Project, Indiana DOT

The *intelli*Rock 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.

Flintco, Inc.
Marriott Courtyard, Oklahoma City, OK

Flintco, Inc., is completing an eight-story, 225-room Marriott Courtyard hotel in downtown Oklahoma City, Oklahoma. Using the *intelli*Rock system optimized post-tensioning and provided reliable temperature profiling during cold-weather concrete operations, which saved one day per pour during the project.

Pavers, Inc.
Pavements, City of Wichita, KS

Using *intelli*Rock™, Pavers Inc. learned that it was obtaining strength for concrete 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.

Duit Construction Co., Inc.
Interstate 30 Pavements

Cold weather threatened to set an Interstate Highway paving job back between six to eight weeks at the outset of the project. Using the *intelli*Rock system, the paving contractor was able to monitor the in-situ temperature of the pavement in real-time, providing the owner with necessary quality assurance data to allow the contractor to proceed as scheduled.

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Maturity Measurement – Testimonies

Federal Highway Administration

The Federal Highway Administration (FHWA) published a study in 1988 showing that field-cured specimens do not accurately reflect the true rate of hydration experienced by the concrete in a structure.[1] These inaccuracies are then amplified when laboratory-cured rather than field-cured specimens are used to estimate in-place concrete strength. The maturity method, however, enables the Contractor and/or Engineer to measure concrete strength in the structure at any time and as many times as necessary until the desired strength is achieved. Because conventional strength-estimation methods require destructively testing cylinder or beam specimens, they can only be performed when:

1) enough test specimens have been cast,
2) destructive test equipment is available at the job site
3) a trained technician is available

Because the maturity method provides a better representation of the in-place strength gain for a concrete structure and can be measured at any time, improved timing can be applied to subsequent construction activities. This improved timing results in maximum time savings without sacrificing safety or quality. In fact, the FHWA stated in 1997 that, *"the maturity method is a useful, easily implemented, accurate means of estimating in situ concrete strength. … In a time when public agencies and contractors are concerned with escalating costs and shrinking budgets, this method provides a viable means of reducing costs through testing and scheduling. Also, quality assurance costs can be reduced because the number … of test cylinders is reduced by using the maturity concept."*[2]

Pennsylvania State University

An analysis of the maturity method by Pennsylvania State University concluded that, "*The maturity method can be used to reduce construction costs. Ansari, et al [1999] estimated that construction time for highway projects could be reduced by as much as 50 percent. Additionally, they stated that the number of companion cylinders cast during construction could be reduced by about 75 percent. Hunt and Mihm [1999] state that the savings potential in Texas have the potential to be remarkable.*"[3, 4, 5]

Texas Det of Transport

The Texas Department of Transportation has been using the maturity method extensively in their Dallas district for over seven years. Projects using maturity have routinely experienced time savings of *3- to 5-days per concrete placement* and a *60% to 70% reduction in the number of cylinder test specimens required per project.*[6]

The Texas Department of Transportation has developed a powerful protocol for verifying that the concrete delivered to a job site truly matches the mix design approved for the project. The procedure can be summarized as follows:[7]

1. Develop a strength-maturity relationship curve for each mix design to be used on the project.
2. During each concrete placement, embed one or more maturity probes into the structure.
3. Cast verification cylinders from the same batch of concrete. Instrument at least one of the verification cylinders with a maturity probe.
4. Periodically check the maturity (also called the temperature-time factor, or TTF) of the structure. When the TTF of the structure indicates that the structure has reached the required strength, note the TTF value of the verification cylinders.
5. Measure the strength of the verification cylinders using conventional "destructive" test methods.
6. Compare the strength of the cylinders (as measured by conventional test methods) to the strength values predicted by the cylinder TTF value (using the appropriate mix-specific relationship curve). If the measured cylinder strength value is close to the predicted cylinder strength value (e.g. within 10%), the mix and the relationship curve have been validated and subsequent construction activities can continue. If the measured strength is not within tolerance, the probable cause is investigated.
7. If the strength discrepancies are due to problems with the batching procedures, corrective actions are taken to ensure that the problems are not repeated.
8. If the source of the observed differences cannot be readily determined, a new strength-maturity relationship curve is developed to account for any potential changes that may have occurred with the mixture components.

Using this or a similar procedure, owner agencies can rapidly identify deviations from the specified mix designs (within a few days after placement rather than several weeks later) and thus take corrective actions in a timely manner.

References

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[2] Crawford, G. I. (1997). *Guide to Nondestructive Testing of Concrete*. (FHWA-SA-97-105). Washington, DC: Federal Highway Administration.

[3] Ansari, F., Luke, A., & Dong, Y., (1999), *Development of Maturity Protocol for Construction of NJDOT Concrete Structure*. Final Report to New Jersey Department of Transportation, December, 34 pp.

[4] Hunt, J. E. & Mihm, A. M., (1999), "*Concrete Maturity Testing in Texas Project*." Better Roads, vol. 69, no. 3, March, pp. 29-30.

[5] Tikalsky, P. J. et al (2001). *Using the Concrete Maturity Meter for QA/QC: Executive Summary*. University Park, PA: The Pennsylvania State University.

[6] Trost, S. M. (2002). *Personal Interview with James E. Hill, Lead Inspector, Dallas District, Texas Department of Transportation (TxDOT)*. Unpublished. Stillwater, OK: Strategic Solutions.

[7] Texas Department of Transportation (TxDOT) (2002). *SPECIAL PROVISION TO ITEM 420 CONCRETE STRUCTURES*.