Minimizing the impact of third-party testing on the Concrete Industry

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Agenda

Variation in third party strength testing

Observed field data

Australian history and methods

FHWA examples

Proposal to improve concrete acceptance testing

Who is Watching Out for the Cylinders?

by Karthik H. Obla, Orville R. (Bud) Werner, John L. Hausfeld, Kevin A. MacDonald, Gregory D. Moody, and Nicholas J. Carino

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Who is Watching Out for the Cylinders?

Proper initial curing of acceptance test specimens benefits all stakeholders

by Karthik H. Obla, Orville R. (Bud) Werner, John L. Hausfeld, Kevin A. MacDonald, Gregory D. Moody, and Nicholas J. Carino

ACI 318-14[1] requires that test specimens prepared for acceptance testing for specified strength shall be subject to standard curing in accordance with ASTM C31/C31M.[2] The strength of standard-cured cylinders does not represent the in-place strength of the concrete in the structure, but it serves as the basis for judging the adequacy of concrete delivered to the project. ASTM C31/C31M also includes an optional "field curing" procedure in which specimens are stored on the structure in an attempt to mimic curing of concrete in the structure. Field-cured specimens are used to determine if a structure may be put into service, evaluate the adequacy of curing and protection of the concrete in the structure, and to help determine form and shoring removal times. Field-cured specimens are not to be used as the basis for acceptance of the concrete as delivered to the project.

Standard Curing

Standard curing of test specimens consists of initial curing at the project site, transportation to the laboratory, and final curing at the testing laboratory. Conditions are specified for each phase. The initial curing portion involves storing the specimens for a period up to 48 hours in an environment that maintains a curing temperature in the range of 60 to 80°F (16 to 27°C) and controls moisture loss from the specimens. For concrete mixtures with a specified strength of 6000 psi (40 MPa) or greater, the initial curing temperature shall be between 68 and 78°F (20 and 26°C). These temperature ranges refer to the temperature of the medium surrounding the specimens, which may be air, water, or damp sand. Curing temperature does not refer to the concrete temperature. After initial curing, the specimens are transported to the testing laboratory. During transport, the specimens are to be protected from mechanical damage (Fig. 1), loss of moisture, and freezing (if applicable). Transportation time is not to exceed 4 hours. The final curing portion involves storing the specimens at a temperature of 73.5 ± 3.5°F (23.0 ± 2.0°C) in water storage tanks or moist rooms conforming to ASTM C511.[3]

An ongoing testing adherence program conducted by the Colorado Ready Mixed Concrete Association (CRMCA) showed that initial curing, as documented by qualified member representatives, was performed in accordance with ASTM C31/C31M at only about half of the project sites observed.[4] Anecdotal evidence indicates that the situation is similar or even worse in other regions (Fig. 2). Further, concrete test reports often do not provide information about initial curing of the specimens, which raises doubts whether test specimens were subjected to initial curing in accordance with ASTM C31/C31M. This article reviews the importance of adhering to the initial curing requirements mandated by ASTM C31/C31M and provides suggestions for ensuring that the responsibility for initial curing be clearly defined at the start of a project.

Fig. 1: Example of improper transportation of test specimens. Early-age specimens are fragile and susceptible to mechanical damage if not protected from jarring. In this example, the specimens are not restrained and can be effected by impact with each other and other surfaces. Lastly, the specimen molds lack covers for controlling moisture loss

Initial Curing is a frequent problem

Field Observation

Properly stored in initial curing environment 1/3 of time

COLORADO READY MIXED CONCRETE ASSOCIATION

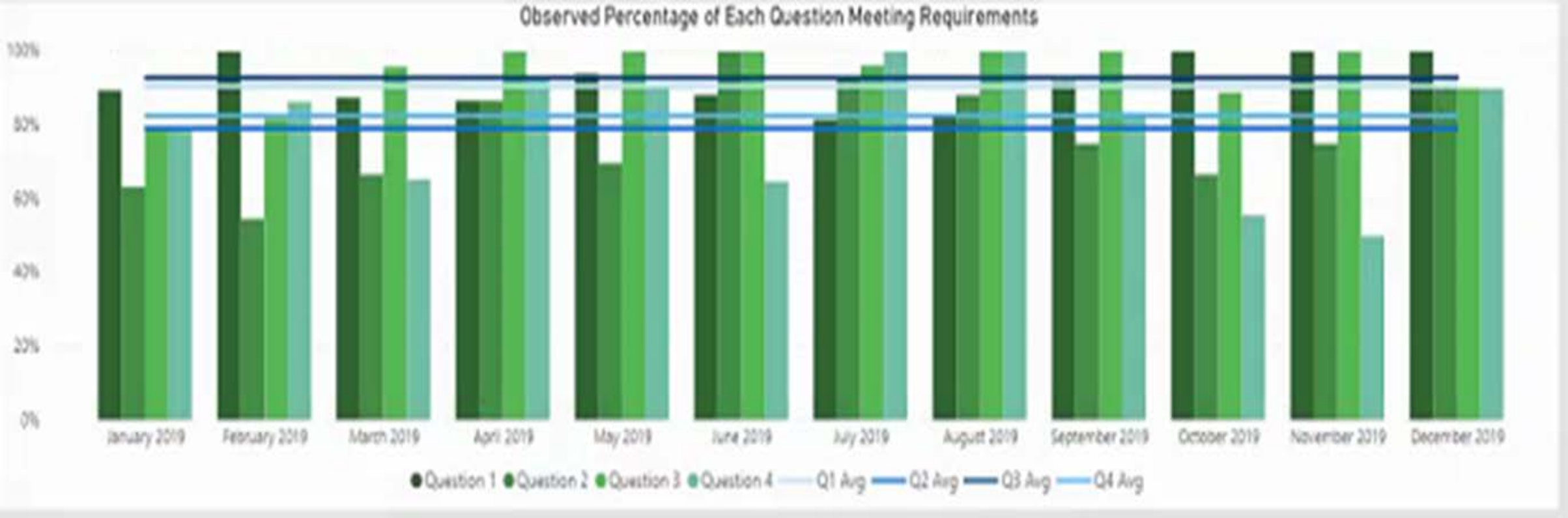
Field Examiner Summary Details

August, 2015*

Contributing Companies	Number of Assessments August, 2015	Number of Assessments YTD
Bestway Concrete	22	96
Martin Marietta	33	121
Ready Mixed Concrete Co.	9	26
Trans Colorado Concrete	4	12
Transit Mix Concrete	8	33
United Companies	8	31
Aggregate Industries	7	18
Metro Mix Concrete	9	9
Grand Junction Ready Mix	13	17
the mixer truck discharge?)	93%	81%

Average Score 9 (Properly stored in an initial curing environment)	**34%**	**30%**

Observed Third Party Technician Data



Business Case for Improving the Initial Curing

Review - Benefits of proper curing

1. Better durability
2. Improved sustainability
3. Reduced construction time
4. Minimize low strength investigations to only genuine situations
5. Foster a better partnering environment
6. Increase confidence in concrete construction
7. Maintain competitiveness

Two most common mixtures with $f'_c \leq 4000$ psi

For mixtures where specifications do not include any one of the following requirements - Max w/cm or minimum cementitious factor or fixed over-design value such as 1200 psi or early-age strength

	Weighted Average				
	2018	2017	2014	2012	2010
Standard deviation (S), psi	484	465	551	491	505
Specified strength, psi	4042	3970	3427	3865	3773
Strength increment, psi	1460	1350	1030	1000	1090

Over design is above our target of 800 psi

Why Target OD = 800 psi?

Statistically a target OD of 800 psi ensures **just** a 1-in-1000 failure probability for good quality concrete (S = 433 psi)

S, psi	Target OD, psi
600	1300
500	1000
433	800
300	520

Average overdesign is 660psi above target overdesign of 800psi. Assuming 1lb of cement represents 10 psi. 66lbs of cement overage = $4.21(assuming $6/sack)

Australian Methods / History

- Prior to 1970 - Trust in Producers Questioned
- 3rd party Testing began in the 1970's and continued to the early 1990's
- Early 1990's - Trust in 3rd Party Testing Companies Questioned
- Early 1990's - Transition to Producer Controlled QA/QC process
- Little to no pushback from the industry

Australian Standards

AS 1379-2007

- Mix Trials to confirm mix is suitable.
- QA tests as construction proceeds.
- Generally producer tested. Third-party lab is the exception.

Producer Accreditation

NATA National Association of Testing Authorities, Australia

- NATA is one of four bodies that form Australia's standards and conformance infrastructure. The others are Standards Australia, the National Measurement Institute and the Joint Accreditation System of Australia and New Zealand.
- Producer, Government and Third-party laboratories.

US Adherence Standards

Federal Highway Administration: CFR 637B

- Quality control sampling and testing results may be used as part of the acceptance decision provided that:
- The sampling and testing has been performed by qualified laboratories and qualified sampling and testing personnel.
- The quality of the material has been validated by the verification testing and sampling. Verification sampling shall be performed on samples that are taken independently of the quality control samples.
- The quality control sampling and testing is evaluated by an IA program.

US Adherence Standards
FHWA: Defined

637B – Prescribes policies procedures and guidelines to assure the quality of materials and construction for Federal Aid Highway projects.

637B aligns with both AASHTO & ASTM. CCRL accreditation required to meet governing standards.

Qualified Lab – Laboratories that are capable as defined by local State Transportation Departments.

ACI Standards

- ACI 301 - 1.6.3.2(e) Owners testing agency will conduct concrete strength test…
  - Owners prerogative
- ACI 318 – 26.12.1.1(b) The testing agency performing acceptance testing shall comply with ASTM C1077.
  - Challenging convention but not the code

Proposal to provide supplier lead concrete testing for the XYZ High Rise Project:

Ready Mix Concrete Supplier:

- Provide on-site testing utilizing ACI certified(or equivalent) technicians and utilizing a CCRL accredited lab(or as agreed)
- We will test all concrete delivered to the project at specified intervals.
- Test results will be shared with the Owner, General Contractor and any other subcontractor involved in a timely manner.
- We guarantee the performance of all concrete supplied.
- In the case there is a test result that does not meet specification, we will provide further testing.

Proposal to provide supplier lead concrete testing for the XYZ High Rise Project:

Owner/General Contractor:

- Provide space, power and access for Curing Box.
- Has the option to hire 3rd party testing company to do side by side testing and/or Field and Lab observation.

Feedback from GC's, Architects & Engineers

- All acknowledged problems with 3rd party testing.
- Not convinced every producer is equally ethical and committed to ensuring reliable and honest results - Architect
- Pulling the business from 3rd party testers could be politically difficult - Architect
- Sees it as a viable option for commercial projects but not likely on state, federal or municipal projects. – GC
- Would need a very high level of confidence in the producer to rely on concrete producer test data versus an independent lab.- PE
- Feels that producer QA is the best and most logical way to go. You could manufacture a superior, economical and more consistent product if the producer could control the entire process – PE

This is How

- Target specific projects to convert and develop case studies
- Overcome objection with a fact based approach.
- Lab Accreditation Programs and Guidance
- NRMCA and State Association Promotion