The New NRMCA Quality Certification Program

Why should companies have a quality management system?

by Karthik H. Obla and Colin L. Lobo

The quality and uniformity of ready mixed concrete delivered to a construction project depend on the quality of its constituent materials, production, and testing. The quality of concrete is impacted by all job functions within a ready mixed concrete company, so each company should maintain a basic quality management system (QMS), supported by management and managed by competent company personnel.

A QMS improves the quality of a company's product by establishing a systematic way of setting quality processes and responsibilities. Companies that have adopted and are certified to the QMS standard ISO 9001[1] have been shown to have higher rates of corporate survival, higher sales, employment, payroll, and average annual earnings per employee than nonadopters.[2] It has also been shown that small businesses achieve proportionally more benefits than larger organizations.

A company's QMS should have defined quality objectives and measurement systems in place to ensure that these objectives are being met. The objectives should not be "motherhood and apple pie"-type statements—they must be measurable, as documented achievement of quantifiable quality objectives facilitates continuous improvement.

As part of this system, all activities and individual responsibilities related to quality should be clearly defined in the company's quality manual (QM), also referred to as a quality control plan. Companies have varying levels of a formal QM. The QM should cover only those tasks that provide a clear quality benefit and can be accomplished with justifiable investment.

Logo of the NRMCA Quality Certification program

Most ready mixed concrete companies have a quality control (QC) department responsible for managing the quality of its product and addressing quality-related problems. In a successful company, the emphasis is on the former (proactive), rather than the latter (reactive).

The NRMCA Plant and Truck Certification Program

The National Ready Mixed Concrete Association (NRMCA) has administered its certification program[3] for production facilities of ready mixed concrete since 1966. Almost half of the plants operating in the United States are certified under the NRMCA program and more than 100 certified plants are located outside the United States. Companies obtaining certification are primarily driven by a requirement in project specifications. For example, the NRMCA plant certification program is referenced in ACI 301-10.[4]

The NRMCA program verifies that the production facility and delivery vehicles conform to industry standards, such as ASTM C94/C94M, "Specification for Ready-Mixed Concrete." This represents only one part of a quality system and does not assure that a quality product will be manufactured and delivered, because other factors are involved. The NRMCA Quality Certification program is the next evolution that encompasses the broader goal of ensuring quality of ready mixed concrete.

The NRMCA Quality Certification Program

NRMCA provides several resources[3, 5-8] for a company to develop its QMS. The more comprehensive NRMCA reference document is the *Quality Management System for Ready Mixed Concrete Companies*,[5] developed using the essential elements of quality management standards of ISO 9000 and made pertinent to the ready mixed concrete industry.

The NRMCA Quality Certification program started with a focus group of practicing designers convened to discuss the evolution to performance-based specifications for concrete.[9] The group recognized a need for a prequalification process that would assure a designer that a ready mixed concrete company could furnish concrete to such a specification using the necessary resources and capabilities. The concept of an external audit checklist was provided to the group, but their preference was a certification-type of prequalification whereby a third party verified a producer's capabilities.

The system of certification was developed and is maintained by the NRMCA's Research Engineering and Standards Committee. The certification criteria establish a minimum standard for QMS in a ready mixed concrete company. A submission for certification is reviewed and approved by an independent auditor selected by NRMCA. Upon receiving approval from the auditor, NRMCA issues a Quality Certificate of Conformance that lists the production facilities included in the submission. The certificate is valid for 5 years. It is anticipated that certification criteria will be reviewed and revised as more companies apply.

The NRMCA Quality Certification program[10] was established in September 2013 to assure the external customer that a ready mixed concrete company has and follows a comprehensive QMS. Toward that end, the criteria for this Quality Certification have been extracted from the broader guideline document to include those aspects that are of interest to the external customer—the owner, engineer of record (specifier), or contractor. This program reviews and verifies that a ready mixed concrete company has a defined QMS that is developed and supported by the company's management; the company hires competent professionals; there is a process in place whereby specifications are reviewed, applicable mixtures are developed, and the mixtures are documented in submittals; there is a process in place for testing and evaluating ingredient materials and concrete mixtures; and there is a process by which corrective action can be taken. These criteria are covered in the six sections of the document briefly outlined in this article along with some highlights of the certification criteria.

Cover of the NRMCA Quality Certification Document

Section 1: Company Quality Manual

Quality objectives

The QM should list two or more quantifiable quality objectives. Measurement systems that track information toward attaining these objectives should be documented in the submittal for certification. Examples of measurable quality objectives are:

- Maintain concrete strength deviation of the top two selling mixtures for each plant to less than 500 psi (3.5 MPa);
- Maintain the amount of rejected concrete due to quality-related reasons to less than 1% of the plant's production;
- Maintain cost to repair, replace, or mitigate hardened concrete issues because concrete did not meet the requirements or expectations of the purchaser or did not satisfy the specification, to less than $0.50/yd^3 ($0.66/m^3); and
- Limit the number of complaints that are verified to be quality-related per 100,000 yd^3 (75,000 m^3) of production to less than four annually.

Though quantifiable, maintaining on-time delivery, 100% customer satisfaction, or a defined level of fuel efficiency are not quality-related measures. The same could be said about maintaining plant and personnel certifications, which are seen more as a means to achieving good quality rather than an actual quality objective. General quality objective statements that cannot be measured or quantified are not acceptable.

Management commitment

For a QM to be a living document that sets the standard operating procedures for a company, it is essential that the owner, president, or general manager of the company or division be responsible for approving and signing the QM as well as ensuring that the needed resources are provided for its implementation. Implementation and modification of the QM should be the responsibility of a quality committee that includes management representation. The quality manager should ensure that all company employees are familiar with the quality initiatives and their responsibilities, and should monitor and coordinate all quality activities.

Section 2: Resources for Quality Management

Personnel qualifications

Qualified and knowledgeable personnel are essential for producing quality concrete. The QM should define job

qualification requirements, including necessary educational qualifications, experience, and scope of responsibilities for quality control/quality assurance (QC/QA) personnel, plant operators, sales, dispatch, and truck mixer operators. This ensures that the company hires qualified personnel on a consistent basis and supports their career growth while employed by the company. The NRMCA's QMS guidelines provide the following descriptions of key personnel:

- **Quality Manager**—Person in charge of developing concrete mixtures and specification review should have at least 4 years of work experience and either a currently valid NRMCA Concrete Technologist Level 3 Certification or a professional engineering license. An alternative is documentation of 7 years of work experience in the required functions for this position;
- **Plant Operators**—Person(s) in charge of batching concrete should have at least 4 years of work experience and a current NRMCA Concrete Plant Operator certification or certification by a state department of transportation (DOT). Work experience includes training on technical topics related to concrete and batching;
- **Field Testing Technicians**—Person(s) conducting fresh concrete testing at the plant or in the field should have a current ACI Grade I Field Testing Technician certification;
- **Laboratory Technicians**—Person(s) involved in and responsible for laboratory tests should have a current ACI Level I Lab Testing Technician certification or documentation of training and 4 years of experience performing specific ASTM test methods and practices; and
- **Truck Mixer Operators**—Operators should have a current NRMCA Concrete Delivery Professional (CDP) certification or have obtained equivalent training of subject matter listed in the certification criteria document.

Laboratory testing capabilities

Laboratories that develop concrete mixtures should document compliance with details listed in the certification criteria document. Laboratory certificates of accreditation by American Association of State Highway and Transportation Officials (AASHTO), Construction Materials Engineering Council (CMEC), American Association for Laboratory Accreditation (A2LA), or other accreditation bodies or laboratory inspection reports with corrective actions documented are acceptable alternatives. A company may use an accredited third-party laboratory to perform concrete mixture development or certain specialty tests for project submittals.

The certification criteria document lists the basic minimum concrete and aggregate tests that laboratories should be capable of performing. Laboratories performing routine quality testing services such as determining aggregate moisture content or grading, evaluating fresh concrete properties, or conducting strength tests should show documentation indicating compliance with details listed in the certification criteria document.

Section 3: Ingredient Materials Quality Management

Current (within past 12 months) material certifications or equivalent statements of compliance with ASTM or other specifications by the supplier for all ingredient material sources being used by the company should be collected, reviewed for conformance, and kept on file. There should be a process in place at the plant to verify that material shipments agree with the material order. For example, a material shipment identified as being No. 57 aggregate per ASTM C33/C33M, "Standard Specification for Concrete Aggregates," should not be accepted if the material received is actually a No. 8 aggregate.

It is not possible for the concrete producer to test each material shipment, and therefore there should be a process in place to evaluate uniformity of the different material ingredients. Material characteristics should be monitored using control charts with control limits that trigger corrective or other action to adjust concrete mixtures. Maintaining manufacture certifications on file is not acceptable. Some of the monitored material characteristics should include:

- **Cement**—Cement uniformity evaluated by either ASTM C917, "Standard Test Method for Evaluation of Cement Strength Uniformity From a Single Source"; data from cement suppliers; or producer-performed tests on samples from selected shipments;
- **Supplementary cementitious materials** (**SCMs**)—SCM characteristics specific to shipments, such as fly ash loss on ignition, available from suppliers or company tests;
- **Aggregate**—Aggregate grading is evaluated at a minimum frequency of once per month of concrete production or every 3000 tons (2700 tonnes) of aggregate used, whichever is more often. Aggregate relative density (specific gravity) and absorption tests should be performed annually. Aggregate moisture content is to be measured at a frequency of once per each day of production and batch adjustments for aggregate moisture documented. Moisture probes, when used, should be checked for accuracy at a minimum once every 6 months; and
- **Nonpotable water**—When nonpotable water is used in concrete mixtures, document compliance with ASTM C1602/C1602M, "Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete."

The QM should outline the testing to be done by the concrete producer and methods of dealing with nonconforming materials. When the concrete producer actively monitors ingredient material variability, the quality practices of material suppliers are likely to improve.

Yard personnel should be trained to manage aggregate stockpiles so as to minimize contamination, segregation, and breakage and to ensure that aggregates with consistent moisture content are loaded into the plant during a period of production. With incoming shipments, yard personnel should be trained to spot incorrect aggregate sizes, changes in grading, or contamination.

Section 4: Production Facilities

Production facilities and delivery vehicles should conform to the requirements of ASTM C94/C94M. This might be accomplished through a current NRMCA certificate of conformance for concrete production facilities or a state DOT approval.

Accuracy of measuring equipment—scales and volumetric devices—should be verified at stated frequencies and corrective action taken as soon as a deficiency is noticed. Procedures should be stated to monitor and to address out-of-tolerance batches. The individual responsible for monitoring batching accuracy should be identified. Water can enter a concrete batch from several sources, so the company should define and follow procedures to control mixing water to within the ASTM C94/C94M tolerance of ±3%. Job-site water addition (if any) should be documented on the delivery ticket and signed by the purchaser, in accordance with ASTM C94/C94M.

Section 5: Product Management

The process and responsibility for review of specifications and orders, as well as the procedure for assigning mixtures and establishing mixture proportions for concrete orders and project specifications, should be defined. The person responsible for establishing mixture proportions should be identified, and the process used for determining target strength and documentation of strength of proposed mixtures for submittals should be established. Evidence of compliance with other prequalification tests, such as those for evaluating shrinkage, alkali silica reactivity, or chloride ion penetrability, should be provided. The company should describe procedures for hot-and cold-weather concreting and making seasonal adjustments to concrete mixture proportions. Mixture adjustments permitted by plant personnel and mixture adjustments requiring approval by technical personnel should be identified. The process used to inform the specifier or purchaser when required should be outlined.

Companies should define a process for receiving and fulfilling orders for concrete, including safeguards to ensure that when an order is placed, correct concrete mixtures are dispatched to the customer. Companies should also have a policy for record keeping. The process of maintaining records of concrete mixture proportions, batch records, delivery tickets, test data, and material certifications should be clearly stated. The period of record retention should be defined in company policy based on type of information, types of project, and jurisdictional requirements.

Selected documentation is required to verify that the stated procedures are being followed.

Sample certificate

Section 6: Measurement Systems

Identification/traceability

Concrete mixtures provided by the company should have a designation or identification that describes the characteristics of the mixture to company personnel. Mixture designations and individual batches sold should be traceable to batch records and delivery tickets with a unique identification number and traceable to truck numbers that delivered the load. This information is useful when troubleshooting concrete problems in the field and for future data mining for quality enhancements.

Customer resolution

There should be a system for capturing customer complaints and a methodology for addressing them. Complaints should be evaluated by the quality committee for needed changes to the QM.

Internal quality audit

Internal audits are important to ensure that quality processes and responsibilities assigned in the QM are being complied with. It also provides a feedback loop on needed resources and changes to the QM. The internal audit process with checklist should be described in the QM. Quality audits should be conducted at least once a year and the team assigned to conduct the audit should be identified. Corrective actions resulting from these audits should be documented.

Internal testing

Internal testing at the plant helps pinpoint the causes of variation of concrete quality and establish best practices. Details involved in internal testing are discussed by Obla.[6] For every plant included in the request for certification, companies should test at least two concrete mixtures at a frequency of once per week or once every 500 yd^3 (380 m^3), whichever results in the smaller number of tests. Tests conducted should include slump, temperature, density, and/or 28-day compressive strength, and air content for air-entrained concrete. Companies should have a procedure of incorporating process improvements based on the data analysis.

QA test records

The company should define the process and personnel responsible for collecting and monitoring QA tests per-

formed by third-party laboratories. Control charts and other statistical processes, should be used to identify potential problems such as low strength and resulting resolution.

Nonconforming acceptance test results

The company should state procedures and responsibilities for identifying and dealing with nonconforming concrete mixtures. Examples include excessive slump, air content, incorrect ingredient or contamination, batching accuracy, or load size. Frequent nonconformances of the same type should be investigated, the underlying reason identified, and if necessary, changes made to the QM.

Returned concrete and wash water

The company should have a policy on the management of returned concrete. Responsibilities should be identified and the policy and process communicated to affected plant personnel.

Summary

The NRMCA quality certification ensures that the company is operating an effective QMS for the production of ready mixed concrete that is well-established, documented, implemented, and facilitates continuous improvement. The audit verifies that the company meets the minimum criteria recognized by this certification program. The certification program can be used to prequalify concrete producers that maintain a quality management system in line with a minimum industry standard when this is needed for higher profile projects and for those with performance-based specifications. NRMCA believes that the widespread use of this quality certification will help raise the quality level of concrete construction, resulting in saving of time and cost for all industry stakeholders.

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Note: Additional information on the ASTM standards discussed in this article can be found at **www.astm.org**.

Selected for reader interest by the editors.

Karthik H. Obla, FACI, is Vice President of Technical Services at the National Ready Mixed Concrete Association, Silver Spring, MD. He has over 20 years of experience in concrete materials technology. He is a recipient of the ACI Young Member Award for Professional Achievement; Chair of ACI Committee 232, Fly Ash in Concrete; and a member of several other ACI committees, including 201, Durability of Concrete; 211, Proportioning Concrete Mixtures; 214, Evaluation of Results of Tests Used to Determine the Strength of Concrete; 236, Material Science of Concrete; 240, Natural Pozzolans; 329, Performance Criteria for Ready Mixed Concrete; 365, Service Life Prediction; 555, Concrete with Recycled Materials; and C601-B, Concrete Quality Technical Manager. He served as President of the San Antonio Chapter – ACI. He received his PhD in civil engineering from the University of Michigan, Ann Arbor, MI, and is a licensed engineer in the state of Maryland.

Colin L. Lobo, FACI, is Senior Vice President of the Engineering Division at the National Ready Mixed Concrete Association, Springfield, MD. He is a member of ACI Committees 211, Proportioning Concrete Mixtures; 214, Evaluation of Results of Tests Used to Determine the Strength of Concrete; 228, Nondestructive Testing of Concrete; 301, Specifications for Concrete; 318, Structural Concrete Building Code; and E701, Materials for Concrete Construction. He is also active in other organizations, including ASTM International, ASCE, TRB, AASHTO, and FHWA. He received his BE in civil engineering from Mysore University, Karnataka, India; his MS from Northeastern University, Boston, MA; and his PhD from Purdue University, West Lafayette, IN.