QUALITY CONTROL GUIDE FOR READY MIXED CONCRETE PRODUCERS

National Ready Mixed Concrete Association

66 Canal Center Plaza, Ste. 250, Alexandria, VA 22314

(703) 706-4800 • www.nrmca.org

QUALITY CONTROL GUIDE FOR READY MIXED CONCRETE PRODUCERS

Table of Contents

NRMCA

National Ready Mixed Concrete Association
66 Canal Center Plaza, Ste. 250, Alexandria, VA 22314
(703) 706-4800 • www.nrmca.org
April 2022

QUALITY CONTROL GUIDE FOR READY MIXED CONCRETE PRODUCERS

Introduction

In this age of high demands on quality and dependability of engineering materials and systems, and the manufacturer's potential involvement in product liability, well-developed quality control systems have become an indispensable part of doing business in many industries. Ready-mixed concrete involves several unique factors which require attention.

1. It is a processed but unfinished material at the time of delivery.
2. The quality and uniformity of concrete vary because of a large number of factors. Some are readily identified and controlled; others can be obscure and not so easily controlled.
3. The quality of the end product is affected by various factors at different phases of processing:
   - selection and variability of ingredients;
   - their proportions;
   - the thoroughness with which they are combined; and
   - conditions related to transportation, placement, and protection of the concrete.
4. In its "as sold" condition, the product is perishable and will not remain in the plastic and unhardened condition beyond a limited time, the exact period depending upon circumstances.
5. Its ultimate quality, compressive strength, cannot be verified at the time of sale, in contrast to other materials such as steel, lumber, and masonry units.
6. The product is subject to testing by others. Variations from standard methods of testing and individual interpretation of methods or criteria result in a misrepresentation of the true quality of the product.
7. While most manufacturing industries enjoy a high degree of standardization of their products, the ready mixed concrete industry is compelled to modify and adjust its product to a host of variables in response to real or perceived needs for the various uses of concrete in a project and to make efficient use of locally available raw materials.
8. It is expected to meet prescriptive as well as performance requirements which may be in conflict.

In summary, the complexity of providing a quality product, and having it recognized and certified as such, presents the concrete producer with a fairly clear-cut choice:

- Use a comfortable safety factor regarding the strength and other measured properties of concrete and trust in good luck; or
- Become committed to a well-organized quality control effort.

The former represents a cost with no potential benefit. The latter is an investment that will produce realized benefits. This guide will be of help if the latter option is selected.

Definitions

Quality Control

also called **Process Control**

- *Sum total of activities performed by the seller (producer, manufacturer, and/or contractor) to make sure that a product meets contract specification requirements. Within the context of highway construction, this includes materials handling and construction procedures, calibration and maintenance of equipment, production process control, and any sampling, testing, and inspection that is done for these purposes.*
- *Actions taken by an organization to provide control and documentation over what is being done and what is being provided so that the applicable standard of good practice and the contract documents for the work are followed*

These concepts of quality control include sampling and testing to monitor the process but usually does not include acceptance sampling and testing.

Quality Assurance (QA)

- *All those planned activities and systematic actions necessary to provide adequate confidence that a product or service will satisfy given requirements for quality. Within an organization, QA serves as a management tool. In contractual situations, QA serves to provide confidence in the supplier.*
- *Actions taken by an organization to provide and document assurance that what is being done and what is being provided are in accordance with the contract documents and standards of good practice for the work.*

Quality Control Plan

A detailed description of the type and frequency of inspection, sampling, and testing deemed necessary to measure and control the various properties governed by agency specifications. This document is submitted to the agency for approval by the contractor during the pre-construction conference.

The term quality control plan is project-specific as opposed to the broader company-specific overview document that describes its Quality Management System (QMS).

Company Policies and Initiatives

Setting up a quality control organization is a part of a company-wide quality decision. Just hiring quality control personnel, purchasing the necessary equipment, and implementing a sampling and testing program does not necessarily assure the production of quality concrete. These efforts might only serve to enlighten management on the current shortcomings of company operations and concrete production. Other decisions need to be made to make the quality control organization a worthwhile investment.

Target Quality

This involves a management commitment to define the desired level of product quality. An important part of setting target quality is to identify and minimize manageable variability to optimize concrete mixtures and production processes to maximize profitability and support sustainability.

There needs to be stated quantifiable quality objectives or goals that are communicated to company personnel along with a measurement process to support them. The decision-making process covers other important matters such as willingness to maintain product quality regardless of competitive pressures. Quality targets should be based on business reasons for improving profitability. Examples of quantifiable objectives include strength standard deviation of mixtures by plant, percent rejected concrete due to quality, and resources (cost and time) attributed to troubleshooting concrete quality issues. Data generated from the process should be used for continuous improvement and not done for the sake of doing it. Less important stated quality targets for quality goals include, for example, customer satisfaction issues. These are important to market the company but are not quality objectives.

Personnel Policies

Selection of qualified personnel for managing product quality and operation of plants and truck mixers has a considerable bearing on delivering concrete of dependable and predictable quality.

Quality control managers and technicians should monitor and control materials and product quality and work in concert with operations and sales personnel.

Plant operators should be capable of operating with a minimum number of errors regardless of outside pressures. They should have the ability to comprehend the effects of various factors on concrete quality and be able to make the right decisions in problem situations.

A higher-than-average degree of alertness, and concern for product quality, is required of concrete delivery professionals, particularly when working in dry-batch operations. It is their job to take the materials weighed into their units and produce well-mixed concrete without impacting the intended product quality. They should be able to use judgment in adjusting its consistency to fit the job specifications. On the job site, they protect the company's interests by carefully recording additions of water and other materials to the concrete and noting any observed malpractice in sampling, placing, handling, and testing.

Good people must be attracted, trained, and retained to control concrete quality within their various job assignments. Training sessions and seminars are necessary to ensure that each person gets the information needed to perform his or her job effectively. Industry certification programs help establish personnel career growth and company reputation.

Selection and Maintenance of Plant Equipment

Investment in dependable plant equipment, including truck mixers, and appropriate maintenance and replacement schedules, will govern the capability of an operation to consistently put out a quality product. The higher initial investment may pay off in the long run if it helps reduce or eliminate costly product failures. For example, automated batching controls will reduce the risk of misbatched loads. Complete physical separation and proper identification of aggregate types and cementitious materials will prevent incorporating incorrect materials in loads. or errors when batching, and can prevent the potentially disastrous effect on concrete performance.

Production facilities and delivery vehicles should conform to the requirements of ASTM C94. This can be ensured by attaining the NRMCA plant inspection certification records or a State DOT plant approval. Scales and volumetric measuring devices should be verified for accuracy at stated frequencies. There should be procedures to monitor and address batches, where materials measured are out of tolerance, and specifically to control mixing water to within the ASTM C94 tolerance of ±3%

Materials Selection and Quality Management

Selection of concrete materials strictly based on economy and with disregard to evidence of variable or inferior quality may be counterproductive by tying up quality control personnel in time-consuming efforts to analyze the causes of resulting substandard or variable concrete performance. A poor-quality concrete material may eventually turn out to produce highly variable concrete fresh and hardened concrete properties and result in rejection of loads and require excessive overdesign of mixtures to avoid failures. While troubleshooting these problems, the unavailability of quality control personnel for other critical assignments is then liable to magnify the company's quality problems.

Current material certification should be retained for materials used to produce concrete. Concrete material data that is used in mixture proportions, such as aggregate relative density, should have been recently measured. When non-potable sources of water are used, there should be documentation for compliance with ASTM C1602 or requirements of the local highway department. There should be a process in place at the plant to verify that material shipments agree with the material order. There should be a process in place for monitoring changes in the characteristics of the primary cement used. This could involve monitoring ASTM C917 test reports obtained from the cement supplier or test measurements or other data of cement monitored on control charts. There should be a process in place for monitoring changes in characteristics of the fly ash or slag cement used. Fly ash uniformity can include data from the fly ash marketer on loss on ignition (LOI), foam index, mortar air content, and similar tests performed by the concrete producer.

Some details in the NRMCA producer quality certification on quality management of materials:

- Aggregate grading tests be performed at a frequency of once per month of concrete production or every 3000 tons of aggregate used whichever is more often and that aggregate relative density (specific gravity) and absorption tests be performed annually.
- Coarse and fine aggregate moisture measured at a frequency of once per day of production and documented batch adjustments for aggregate moisture.
- Moisture probes, when used, are checked for accuracy at a minimum once every 6 months.

Within-Company Coordination of Quality Control

The person in charge of the quality control organization should have the appropriate authority and be directly responsible to the general manager of the company or division of which it is a part. He or she implements management's decision on the quality level of the product; and reports, usually weekly, on product and production performance. He or she works with the production department to develop means of maintaining and improving the quality level and cost efficiency of production and monitors their successful implementation. Quality control activities should be coordinated with the production and sales departments. In turn, the quality control personnel depend on these departments for information that will result in an optimum contribution by the quality control organization to the company's business objectives. This communication becomes especially important when considering jobs with specifications using statistically-based acceptance criteria with penalty clauses since a knowledge of the level of production variability is critical to the decision to bid. Bidding on work that is not typical for the company should be coordinated between sales and quality control personnel.

Scope of Quality Control Activities

Quality Control has become a convenient label for several functions that not only include the design and control of the company's product but several activities only indirectly related to the control of quality. Quality control initiatives should be proactive to minimize the variability and ensure that a defective load is not delivered to the customer. Quality control that is primarily reactive and focuses on troubleshooting problems after the fact does not provide any benefit to the company.

Quality control activities usually include:

- sampling and testing of concrete and concrete materials;
- plant and field control of concrete production;
- evaluation and procurement of new equipment and tools to improve quality;
- concrete mixture optimization;
- research and development testing;
- specification review;

- evaluation of concrete performance;
- failure analysis and prevention;
- documentation preparation for customers and producer management; and
- facilitation of continuous improvement.

Additionally, quality control functions may include personnel training, various promotional activities, and company representation in industry and professional groups. The various specific tasks necessary to fulfill the company's quality objectives should be clearly defined, personnel assigned, and frequency for performing the task established. The defined processes should be uniform across the company's plants and divisions, as much as possible, so that when one individual cannot complete a particular task an alternate who knows the task can fill in.

While a concrete producer QC department should be proactive and prevent problems, it is not unusual for a large proportion of a QC manager's time to be occupied by unscheduled events, such as:

- Customer issues and complaints
- Availability of materials, the need to change materials, and adjustment to mixtures
- Last-minute requests from Sales and Production
- Issues arising from production or test equipment

Since these events are not planned, it is important to recognize that the events will occur and to develop a process for resolving them in advance of them happening. For example, if the Sales department requires a mixture submittal in a short period, a system should be in place to accomplish this in the absence of the person who typically does this.

Quality Control Staffing

The Quality Control Manager works to implement management's objectives concerning the desired product quality within the overall quality commitment of the company. He or she establishes quality standards for concrete materials and sets up a quality control plan which specifies the scope and frequency of sampling and testing. The QC Manager's assignments usually include

- review of project specifications and selection of job mixtures;
- preparation of concrete mix designs and other product information for approval by the specifying agency;
- evaluation of concrete performance;
- product optimization;
- research and development testing;
- failure analysis and prevention;
- personnel training; and
- advising on technical aspects of promotional activities.

The Quality Control staff often includes quality control technician(s). Control functions of this unit involve primarily the sampling and testing of concrete materials and concrete mixtures, and control of production at the plant and in the field. It may represent the entire quality control operation of a small company, or maybe one of several in a multi-plant company. In smaller companies, these functions may be handled by various members of the management team. In some companies, these functions may be performed with the assistance of outside consultants or laboratories.

Company Laboratory

While not all concrete producers need a dedicated laboratory space, all producers should have the equipment and qualified personnel to perform basic tests on materials and concrete. The company's laboratory may be very basic to perform basic tests on materials and concrete. These include aggregate tests such as sampling (ASTM D75), reducing samples to test size (ASTM C702), aggregate moisture content (ASTM C566), sieve analysis of coarse and fine aggregates (C117 and C136); and preparing trial batches of concrete mixtures (ASTM C192) along with fresh concrete tests such as slump (C143), air content (C231, C173), density and yield (C138), and temperature (C1064).

Laboratories can also have capabilities for advanced testing depending on the company's quality initiative, innovation, and type of market served. These additional tests include relative density and absorption of coarse and fine aggregate (ASTM C127 and C128), LA abrasion test (ASTM C131 or C535), soundness test (ASTM C88), unit weight and voids (ASTM C29). For concrete tests, maintain curing tanks/rooms meeting (ASTM C511), capping cylinders (C617 or C1231), compressive strength (C39), and flexural strength (C78). Some larger companies may have several smaller satellite laboratories capable of performing routine aggregate and concrete testing with a larger central laboratory capable of performing more advanced work. More advanced testing capabilities such as material compatibility evaluation (ASTM C1753, C1810, and C1827), drying shrinkage (ASTM C157), rapid indication of chloride ion penetrability (ASTM C1202), resistivity (ASTM C1876), and ASR testing (ASTM C1260, C1567, and C1293) could be developed. Some or all of these advanced testing capabilities could be contracted with a commercial laboratory. Developing these capabilities helps the company respond to performance-based specifications or to develop innovative concrete mixtures for regular or special applications.

The laboratory should be staffed by senior and junior quality control technician(s) and is usually under the supervision of a quality control manager or an assistant. The proficiency of the laboratory and its personnel should be maintained by periodic third-party inspections and possibly accreditation, and participation in reference sample testing programs. A proficient laboratory could develop the necessary information for project submittals rather than using independent laboratories.

The company's laboratory represents a sound investment only if it generates reliable information. Erroneous test data may either produce a false sense of security or lead to action inappropriate to the occasion, to the detriment of the producer's business. Testing errors are the result of incorrect testing procedures, mistakes in the processing of samples and specimens, or equipment out of calibration. The following measures taken at regular intervals will help to control these potential causes of testing errors.

1. Quality control staff is examined for proficiency in test procedures. Results are recorded. Technician certification is available from several organizations, including ACI, NRMCA, and state transportation departments.
2. Maintain documentation of the laboratory equipment inventory.
3. Ensure that equipment is calibrated and verified at a frequency established by applicable standards. Audits are performed to ensure that equipment is checked for conformance with applicable methods of test. A laboratory manual that tracks these verifications is maintained in which schedules are listed and results of verification, adjustments, and corrective actions are recorded. For example, verification is documented annually for – scales and balances, slump cone (ASTM C143). air content (C173), temperature (C1064), dimensions of cylinder molds (C470), compression machine (C39) if used, and sieves are checked for defects and verification procedure. The frequency is at every 3 months for pressure air meters (C231), and sulfur capping (C617), if used. Curing tanks/rooms if available can be used for curing test specimens and meets the requirements stated in ASTM C511.

4. Monitoring whether the within test precision of each test method is not violated often.
5. Testing a known standard material periodically (an aggregate for ASR test)
6. Audit procedures for identification and processing of materials and test specimens, and record-keeping of results.
7. Participation in inspection and proficiency sample testing programs such as those offered by CCRL, comparison testing on same samples jointly with other laboratories, and accreditation of the laboratory for conformance with ASTM C1077 and AASHTO R18.

Product Management

There should be a process defined for:

- Review of specifications and orders for concrete and assignment of mixtures.
- Concrete mixture development, and review of the submittal process
- Receiving orders, order entry, and verification of order fulfillment

Procedures should be stated and followed for hot and cold weather concreting if applicable. There should be responsibilities assigned for adjustments to batch quantities and mixture proportions for established mixtures. Certain types of adjustments should be permitted by plant personnel while certain adjustments require approval by technical personnel. There should be a stated record retention policy that meets the local jurisdictional requirements. Records retained include those for maintaining batch records, delivery tickets, and test data on concrete mixtures.

Measurement Systems

There should be a process defined for:

- Establishing internal concrete mixture codes and mixture designations for communications with customers.
- Ensuring traceability of designated mixtures in the company's databases to batch recordation and delivery tickets.
- Product defect resolution
- Internal testing such as regular testing of at least one concrete mixture from each plant by company personnel and data analysis
- Collection and monitoring of quality assurance tests performed by third-party labs, data review, and corrective action
- The identification and management of non-conforming concrete mixtures
- Managing returned concrete, when reused in whole or part

There should be an annual internal quality audit with the company. The audit should use a checklist that ensures that the details of the Quality Manual are being followed at the plants. Corrective action identified in the audit should be completed in a timely manner.

Personnel Training

The quality control department can provide technical training resources, or identify relevant industry training and certification programs, for advancing the professionalism of all company personnel. A basic understanding of concrete technology and the company's quality standards fosters personal involvement in product quality and will lead to making the right decisions in problem situations. The qualification of quality control personnel for their teaching functions is built up through attendance at industry seminars and short courses, through a study of pertinent publications, and correlation of theoretical information with practical experience in the field. Training aids, either prepared in-house or obtained from outside sources, can be used to lend substance to the training sessions and make them interesting. The content of the training program should be established for each type of job function within the company. See information on the range of instruction subjects for different personnel later in this document. The effectiveness of the training sessions is enhanced by administering a quiz at the end of each session. It will provide a means for gauging the success of the teaching efforts.

The NRMCA producer quality certification states that:

- The person in charge of mixture proportions and specification review should be a licensed engineer or possess an NRMCA Concrete Technologist Level 2 Certification and possibly Levels 3 and 4; or ACI Concrete Quality Technical Manager certification with several years of experience in documenting responsibility for mixture proportioning and specification review.
- At least one field technician should have a current ACI Field Grade 1 certification.
- At least one laboratory technician should have a current ACI Lab Testing Technician Level I or have 4 years of experience in concrete and aggregate tests
- At least one person at each plant who is in charge of batching concrete should have a current NRMCA Concrete Plant Operator certification or DOT batchman certification or have 4 years work experience and technical education related to batching concrete
- At least two truck concrete delivery professionals at each plant should have NRMCA Concrete Delivery Professional certification or documented training on technical topics outlined later in this document.

Communications

The usefulness of a quality control department depends to a large extent upon its participation in the flow of communications within the organization. A communications model is presented which illustrates the desirable flow of communications involving the quality control organization at various phases of a project.

Job Progress Communications

Job Phase	Information	From	To	Action Required
Planning Stage (Owner or A/E)	Type of project; Job size	Sales	QC	Provide specification input. Present performance histories of concrete and aggregates to out-of-area A/E offices. Forward to owner information on long-term benefits of concrete pavements and parking lots.
Solicitation of Bids	Availability of specifications	Sales	QC	Specification review; obtain clarification from A/E as needed.
		QC	Sales	Mix recommendations for price quotations.
		QC	Materials	Determine availability and cost of special materials.
		QC	Operations	Input on special delivery requirements and equipment for a cost estimate.
Pre-Bid Conference	Where and When	Sales	QC	Resolution of conflicting and overly restrictive specification requirements. Clarification of responsibilities for special items (for example, site addition of admixtures) Provisions for extra testing costs if high-strength concrete is specified.

Job Phase	Information	From	To	Action Required
Job Award	Name of Contractor	Sales	QC	Technical information to contractor, including performance history of company's concrete on previous similar jobs. Available performance options for rapid form cycling or reducing labor costs.
Selection of Concrete Supplier	"Job Sold!"	Sales QC QC QC QC	QC Materials Operations Dispatcher Accounting	Mix design submission Order special concrete materials Batching information to batch plants List of job mixes, with "red-flagging" of special mixes, special concrete properties, and delivery requirements Mix identification and material quantities
Pre-Construction Conference	Where and When	Sales	QC	NRMCA has a sample pre-construction conference checklist developed in partnership with the American Society of Concrete Contractors. A sample pre-pour conference is provided at the end of this document. NRMCA also has a sample preconstruction concrete acceptance testing checklist that highlights issues related to proper acceptance testing.
Job Start	Advance notice of first delivery	Sales	QC	Pre-test special materials for specification compliance. Review plant handling of materials (for example, pre-wetting of lightweight aggregate to be used in pump placements). Correctness of batching information.
	Placement schedule	Dispatcher	QC	QC representative reviews the next day's orders for correct mix use and assigns QC field personnel on basis of job priorities and the type of concrete ordered.
Job in progress	Test reports from independent lab	QC Mgr.	QC Staff	Log test data; investigate causes of strength fluctuations and other job problems.
	Customer comments on product performance	QC Mgr.	Management	Weekly review of product performance; recommend action as needed to maintain specification compliance, product uniformity, and customer satisfaction.
	Driver Notes on Delivery Ticket	Operations	QC	Notes on slump control, the addition of retempering water or admixtures, and testing practices. Customer-related safety issues must receive immediate attention.
Job Completion	Summary of test data; statistical evaluation	QC	Management Operations Sales	Review of performance level of plants. Recommendations for mix optimization in future projects. Suggestions for promotional use of job data.

Promotion and Industry Representation

The promotional value of a company's quality control operation can be more fully realized through its involvement in various activities such as

1. Promoting the company's business by demonstrating a sound technical knowledge of its products and applicability to the customer's needs;

2. Improving the handling of the product by the customer, and the testing by others, of the company's concrete;
3. Working toward wider use of concrete by owners, designers, and builders.

Promoting the Company Business

- Presentation to customers of successes on previous major or special projects, including performance data of concrete mixtures used on projects for strength, durability, or other properties.
- Demonstration of the scope and qualifications of the company's quality control organization, including reference to the credentials of its personnel and laboratory.
- Documentation of plant and mixer inspection schedule and plant certification, if applicable.
- Assistance to customers toward cost efficiencies and quality improvements in placing and finishing concrete.
- Distribution of technical literature, such as the NRMCA Concrete In Practice brochures and other publications with the company imprint, as applicable to various job situations.

Promoting Good Practices in Handling and Testing of Concrete

- In conjunction with other concrete producers, and with assistance from outside organizations, schedule seminars for local builders, contractors, and concrete finishers in which the basics of quality concrete and proper practices for obtaining strong, durable, and defect-free concrete are explained. Suitable subjects include control of mixing water content; the importance of air-entrainment; cold and hot weather concreting; crack prevention in flatwork through correct joint design; and benefits of proper curing of concrete.
- Finishing demonstrations emphasize the importance of correct timing of finishing operations.
- Demonstration with local testing agencies on correct testing practices and discussion of adverse effects of various improper testing procedures.

Promoting Uses of Concrete and Realism in Concrete Specifications

- In presentations directed at owners, designers, and builders, and with engineering support from industry associations, explain the advantages and efficiencies of using concrete in various applications including tilt-up construction; city street and parking lot pavements; thermal insulation value due to concrete mass.
- Sponsor manufacturers' presentations on innovations in the use of various supplementary cementitious materials and chemical admixtures and benefits imparted to handling characteristics; hot weather performance of concrete; and durability of concrete. In general, the versatility of concrete as a construction material should be demonstrated.
- Schedule panel discussions on realism in concrete specifications and the promotion of performance-based specifications, to address cost-effective use of local materials; the need for appropriate tolerances in strength, durability, and various fresh properties such as slump and air-entrainment; reduction in job mix variables for optimum plant control of concrete; limitations of the water-cement ratio concept in concrete mixture design and field control of concrete; and sampling and testing of concrete -- the right way.
- Suggest standard practices for ordering concrete with appropriate reference to ACI and ASTM standards that will help ensure that concrete of the proper quality level will be provided for typical local uses in public, commercial and residential construction.

Company Representation in Industry Groups

- Technical Industry Committees: Membership in these provides participation in efforts of improving industry standards and of technical specifications on concrete including those of governmental agencies. The networking benefits from this process are invaluable.
- Specification-Writing Groups: These offer a direct forum for presenting the industry point of view on existing and upcoming standards governing materials specifications and methods of test. Membership on ACI and ASTM Technical Committees and regular attendance at their Conventions. Participation in local ACI Chapters.
- Professional Associations: Personal involvement in these, and the presentation of special programs, serve to advance the reliance by design professionals on concrete as a versatile and dependable building material.
- Membership on the technical committees of NRMCA and state ready mixed concrete association where local and national industry initiatives can be better progressed through larger industry groups rather than individual company initiatives.

Topics for Personnel Instruction

Quality Control Staff

Sampling and testing of concrete and concrete materials
Batch data preparation and analysis
Mix design Submission
Batch plant and mixer inspection
Quality limits and action on non-compliance
Investigation of abnormal test results (in-house and other)
Statistical evaluation of strength data
Communications with customers
Job site control functions
Slump control procedures
Proportioning concrete mixes; trial batches
Laboratory procedures
Laboratory quality control
Troubleshooting and report writing
Schedule of testing and job priorities
Processing and filing of test reports
Specification review
Innovations in concrete technology
Safety procedures

Plant Operators

Basic concrete technology
Types of concrete and concrete materials
Aggregate moisture tests and adjustments
Effects of changes in materials (gradation; relative density)
Slump and air control procedures
Plant inspection (NRMCA Plant Check list)
Company policy on handling of returned concrete
Disposition of misbatched loads
Inventory taking and potential causes of inventory losses
Mechanics of scale train and other batching equipment
Yield adjustments on lightweight concrete
Quality control procedures by materials handlers
Response to rejection of concrete loads

See NRMCA Plant Operator Manual

Concrete Delivery Professionals

Basic concrete technology
Types of concrete and concrete materials
Mixing requirements, initial and after water additions
Control of slump and air
Company policy on job site water additions
Truck and mixer operation, maintenance, and production of concrete Testing methods and recognizing improper procedures
Company policies on the handling of returned concrete of apparently misbatched loads
Factors impacting concrete due to ambient temperature
Correct practices in handling and finishing concrete
Handling of customer complaints about product quality
Response to rejection of concrete at the site
Delivery tickets and jobsite notes
Environmental regulations – delivery and jobsite
Safety – driving and personal

See NRMCA CDP Manual

Dispatcher/Office Personnel

Basic concrete technology
Types of concrete and concrete materials
Slump and air control procedures
Mix identification system
Handling of customer complaints and claims regarding product quality
Response to rejection of concrete at the site
Company policy on handling of returned concrete
Within-company communications

Sales Representatives

Basic concrete technology
Types of concrete and concrete materials
Mix identification system
Specification review
Handling of customer complaints and claims regarding product quality
Response to rejection of concrete at site
Testing methods and recognizing improper procedures
Within-company communications
Slump and air control procedures
Strength test reports and promotional use
Innovations in concrete technology - selling added value

Sample Quality Control Plan

Some specifications require the contractor or the material supplier to submit a Quality Control (QC) Plan, which describes the quality control system and processes that will be used to ensure the delivery of a uniform product that meets the specification requirements. Besides outlining the QC functions of the contractor and material supplier, it identifies the responsibilities of the various parties involved and can serve as a useful document in the event of a dispute.

This Sample QC Plan is related to the responsibilities of a concrete producer and is intended to serve only as an example. Producers developing their individual plan should determine what are reasonable inspection and testing frequencies depending on the nature of their production process and the quality and uniformity of their locally available materials. The minimum content of the plan should be established according to the requirements of the job specifications. Once a QC plan has been developed for a particular plant, it is easily modified to suit the purposes of other specifications.

THE READY MIXED CONCRETE COMPANY

PO BOX 5555, ANYTOWN, ST 55555

PHONE (555) 555-5555

April 22, 2022

QUALITY CONTROL PLAN

Project	Bridge Deck on I 95 at SR 250
Project ID	Project # 97-890
Bid Items	Bridge Deck, Headwalls
Contractor	The Concrete Contracting Company
Material Supplier	The Ready Mixed Concrete Company
Product	Ready Mixed Concrete
Compiled by	Mr. C.L. Smith
Date	April 22, 2022

TABLE OF CONTENTS

Page Number

GENERAL INFORMATION

COMPANY INFORMATION

Company Name The Ready Mixed Concrete Company

Address PO Box 5555, Anytown, ST 55555

Phone (555) 999-9999 Fax (666) 999-9998

PERSONNEL

District Manager:	Mr. J.R. Ewing	Phone (555) 111-1111	Email: jewing@rmc.com
QC Supervisor	Mr. C.L. Smith	Phone (555) 222-2222	Email: csmith@rmc.com
Plant Operator:	Mr. E.L. Gardener	Phone (555) 333-3333	Email: egardener@rmc.com
Technician:	Ms. T.R. Wright	Phone (555) 444-4444	Email: twright@rmc.com
Technician	Mr. J.F. White	Phone (555) 555-5555	Email: jwhite@rmc.com

MATERIALS TESTING FACILITIES

Name The RMC Testing Lab

Location 888 First Street, Watertown, ST

Lab Manager Mr. T.W. Walls Phone (555) 345-6789 Email: twwalls@rmctest.com

MATERIALS

SOURCE OF MATERIALS

This information is provided with the mixture submittal for the project

CERTIFICATION DOCUMENTS

Cement

Manufacturers Certification - Mill Test Reports and ASTM C917 reports will be maintained on file.

Fly Ash

Suppliers Certification - will be maintained on file. Bag samples of fly ash from each shipment will be stored for 1 year after termination of the project.

Water and Ice

City water will not be tested. The Ice Company uses city water and it will not be tested

Fine Aggregate

Producers certification including the following information will be maintained on file:

- Type of aggregate
- Grading
- Relative Density
- Absorption
- Fineness Modulus
- ASTM C 33 requirements

Coarse Aggregate

Producers certification including the following information will be maintained on file:

- Type of aggregate
- Grading
- Nominal Maximum Size or Size Number
- Relative Density
- Absorption
- Bulk Density
- ASTM C33 requirements

Chemical Admixtures

Manufacturers Certification for conformance with ASTM C494 and C260 will be maintained on file.

MATERIAL HANDLING

Material	Delivery to Plant	Storage to mixer
Cement	Trucked from terminal to plant in dry bulk tankers, pneumatically conveyed to overhead waterproof silos.	Gravity feed from silo to weigh hopper. Discharged on belt into mixer
Fly ash	Trucked from supplier to plant in dry bulk tankers, pneumatically conveyed to overhead waterproof silos.	Gravity feed from silo to weigh hopper. Discharged on belt into mixer
Fine Aggregate	Truck transport from pit to plant stockpile. Rubber tire loader from stockpile to aggregate loading hopper.	Conveyor belt from aggregate loading hopper to aggregate weigh hopper, gravity fed to conveyor belt to mixer.
Coarse Aggregate	Truck transport from pit to plant stockpile. Rubber tire loader from stockpile to aggregate loading hopper.	Conveyor belt from aggregate loading hopper to aggregate weigh hopper, gravity fed to conveyor belt to mixer.
Chemical Admixtures	Liquid admixture delivered to plant in bulk truck tankers and pumped to water-tight above-ground storage tanks which are clearly labeled.	Admixture is pressure fed into volumetric measuring devices with sight gages and pressure fed into the batch water line for introduction to mixer

PROCESS CONTROL

INSPECTIONS

Items	Check for	Frequency	Personnel
Scale Calibration	Calibration	1 / 6 months	ELG
	Maintenance tolerance		TRW/JFW
Water batching devices	Calibration	1 / 6 months	ELG
	Batching accuracy and leaks		TRW/JFW
Admixture dispensers	Calibration	Annual	TRW/JFW
	Batching accuracy and leaks		TRW/JFW
Central mixer	Visual inspection of blades & buildup		TRW/JFW
	C94 uniformity tests		ELG/JFW
Aggregate stockpiles	Visual inspection of segregation and contamination		TRW/JFW
Cementitious material bins or silos	Visual inspection for weather-tightness and leaks		TRW/JFW
Conveyor belts and rollers	Visual inspection for wear and alignment		TRW/JFW
Aggregate moisture meters	Check calibration		ELG
Trucks	Visual inspection of blades & buildup		TRW/JFW

QUALITY CONTROL TESTS AND FREQUENCY

	Fine Aggregate	Coarse Aggregate	Fresh Concrete
Sampling Method	ASTM D75	ASTM D75	ASTM C172
Location*			
Personnel	JFW	JFW	JFW/TRW

Item	Method	Frequency*
Fine Aggregate		
Grading	ASTM C136	
Moisture	ASTM C566	
Coarse Aggregate		
Grading and FM	ASTM C136	
Moisture	ASTM C566	
Fresh Concrete		
Slump	ASTM C173	
Air Content	ASTM C231	
Yield	ASTM C138	
Temperature	ASTM C1064	
Compressive Strength	ASTM C31 ASTM C39 4 cylinders tested 2 each at 3 or 7 and 28 days.	.

* Location and Testing frequency will be set by the company

Non-Complying Material and Corrective Action

Test	Control Criteria*	Corrective Action
Fine aggregate		
Grading		When two consecutive tests indicate out of spec material, contact supplier. All out of spec material will be separated and marked to prevent inadvertent use.
Fineness Modulus		Make changes to mixture proportions and notify supplier
Moisture		Make necessary adjustments to batch weights
Coarse aggregate		
Grading	Same as fine aggregate	
Moisture		Make necessary adjustments to batch weights
Fresh Concrete		
Slump		Plant operator will be notified to make proper adjustments.
Air Content		Same as for slump
Temperature		Report to plant, use ice/hot water as needed to maintain target temperature. Adjust mix for water demand/set time
Compressive Strength	.	Look for correlations with C917 and if needed notify cement supplier. Check the cementitious materials batchers for accuracy. Check whether the 3 or 7-to-28 day strength gain is within the typical range for that mixture. Increase the cement content or use admixtures to increase the strength level.

*Control limits are not to be confused with specification tolerances and will be set by the company

REPORTS, STATISTICAL DATA, AND CHARTS

Fine Aggregate Grading

Report: Test results will be recorded on a preapproved report form.

Chart: Individual size fractions will be plotted on a Run Chart with the control limits at 10% of the specification range as follows:

Sieve	Percent Passing	
Size	Spec. Range	Control Range
3/8 in.	100	100
No. 4	95 - 100	95.5 - 100
No. 8	85 - 100	87.5 - 100
No. 16	65 - 97	68 - 94
No. 30	25 - 70	29 - 66
No. 50	5 - 35	8 - 32
No. 100	0 - 7	1 - 6
No. 200	Max. 4	3

Coarse Aggregate Grading

Report: Test results will be recorded on a preapproved report form.

Chart: Individual size fractions will be plotted on a Run Chart with the control limits at 10% of the specification range as follows:

Sieve	Percent Passing	
Size	Spec. Range	Control Range
1 ½ in.	100	100
1 in.	95 - 100	95.5 - 100
½ in.	25 - 65	29 - 61
3/8 in.	20 - 40	22 - 38
No. 4	0 - 10	0 - 9
No. 8	0 - 5	0 - 4.5

Air Content

Report: Test results will be recorded on a preapproved report form.

Chart: Air content will be plotted on a Run Chart with control limits of ±1.2% for specified air content greater than 5%.

Slump

Report: Test results will be recorded on a preapproved report form.

Chart: Slump will be plotted on a Run Chart with control limits of ± 0.75 inch for specified slump less than 4 inches and ± 1.50 inches for specified slump greater than 4 inches.

Temperature

Report: Temperature will be recorded on a preapproved report form

Chart: Temperature will be plotted on a Run Chart with control limits of ±10° F of design value for the mixture. If they are exceeded mix adjustments may be needed to address water demand, set time.

Compressive Strength

Report: Test results will be recorded on a preapproved report form

Chart: Test results (average of 2 cylinders) for 3 or 7 day strengths will be plotted on a Run Chart with control limits as ±3 standard deviation (± 3S).

Individual test results and the running average of three consecutive 28-day strength results will be plotted on Run Charts. The control limits for the individual test results will be ±3S. The control limits for the running average of 3 tests will be $[\pm 3 \times (S \div \sqrt{3})]$, where S is the standard deviation of individual test results.

Standard deviation (S) will be calculated from at least 15 tests of the same class of concrete. Standard deviation will be recalculated when 30 tests are accumulated. The control limits will be updated when 30 new test results are obtained.

DOCUMENTATION AND RECORDS

Records will be filed:

Location First Street Plant, 888 First Street, Watertown, ST

Contact Mr. E.L. Gardener

Phone (555) 333-3333 Email: egardener@rmc.com

- Quality Control Plan
- Approved Concrete Mix Designs
- Project Specifications
- Plant Information and Certification
- Scale Calibration Records
- Plant Inspection Reports
- Truck Inspection Reports
- Personnel Certification
- Laboratory Accreditation
- Material Certifications
- Delivery Tickets
- Reports of quality Test Results
- Statistical data and charts for the following quality test data
    - Fine aggregate grading
    - Coarse aggregate grading
    - Air content
    - Slump
    - Temperature
    - Compressive strength
    - Other tests required by specification

Additional References

1. Improving Concrete Quality, K H. Obla, published by CRC Press, Taylor& Francis Group, 2015.
2. Quality Management System for Ready Mixed Concrete Companies, William B Twitty, P2P Steering Committee, NRMCA, www.nrmca.org/p2p
3. ACI 121R, Quality Management System for Concrete Construction
4. Concrete Mix Design, Quality Control and Specification, 4th Edition, Ken W. Day, James Aldred, Barry Hudson published by CRC Press, Taylor& Francis Group, 2014.
5. PCA Design and Control of Concrete Mixtures

Sample Forms

The following sample forms can be customized and developed by company's specific to their needs

- Specification Review
- Mix Design Report
- Report of Concrete Mix Design – Laboratory Trial Batch Data
- Submittal for Strength According to ACI 318 Requirements
- Report of Plant and Truck Inspection
- Quality Control Report – Aggregate Grading
- Quality Control Report – Concrete Tests
- Report of Truck Delivery Analysis
- Report of Weather Data
- Report of Jobsite Analysis
- Report of Material Inventory

REVIEW OF SPECIFICATION

Project ____________________ By ____________________

Date ____________________ Miles to Job ____________________

Estimated Round Trip Time ____________________ Type of Construction ____________________

	Mix 1	Mix 2	Mix 3	Mix 4
1. Strength requirement, psi				
2. Estimated cubic yards				
3. Minimum cement factor				
4. Maximum water-cement ratio				
5. Type of cement				
6. Air content with tolerance				
7. Slump requirement				
8. Fine aggregate (natural or manufactured)				
9. Coarse aggregate size				
10. Admixtures -- AEA				
-- Retarder				
-- Water Reducer				
-- Calcium Chloride/Accelerator				
-- HRWRA				
-- Fly Ash				
-- Slag				
-- Silica Fume				
-- Other				

11. Governing standards ____________________

12. Testing requirements and by whom ____________________

13. Mix designs -- Field proven ____________________ Lab ____________________

14. Penalty, Bonus, or Warranty Requirements ____________________

15. Quality control plan required -- Yes ____________________ No ____________________

16. Possible placing techniques -- Dump from truck ____________________

-- Crane and bucket (size) ____________________

-- Pump make and size ____________________

-- Belt conveyor ____________________ Other ____________________

16. Comments on Specifications ____________________

____

17. Job Site Curing -- Concrete Construction ____________________

-- Test Cylinders ____________________

18. Variance needed ____________________

SAMPLE MIX DESIGN REPORT

Concrete Supplier ____

Project ______________________________ Contractor ______________________________

Mixture Identification ____________________ Specified Strength, f'_c ______________ psi

Specified Slump: ____________ inches Specified Air Content: __________%

Required average strength, f'_{cr}

☐ Based on past performance records (report attached) __________ psi

☐ New mix (trial batch report attached) __________ psi

MATERIAL PROPERTIES AND SOURCE

Cementitious Material	Type	Source	Specific Gravity
Cement			
Pozzolan/Slag			

Admixtures	Name	Source	Dosage, fl.oz.

Aggregate	Type	Source	Sp. Gr. SSD	Abs., %	Fine - FM	Coarse - DRUW, pcf
No. 1						
No. 2						
No. 3						

BATCH QUANTITIES

Material	Quantities per cu.yd.	Abs. Volume, cu.ft.
Cement, lb.		
Mixing water, gal (or lb.)		
Pozzolan/Slag, lb.		
SSD Aggregate 1, lb.		
SSD Aggregate 2, lb.		
SSD Aggregate 3, lb.		
Air, percent		
TOTAL		

Comments: ____

____

Signature: ______________________________ Date: ______________

Title: ____

Organization: ____

SAMPLE REPORT OF CONCRETE MIX DESIGN - LABORATORY TRIAL BATCH DATA

Laboratory ______________________________ Date ______________

Address ______________________________

For Company ______________________________

Project ______________________________

SOURCE OF MATERIALS

Cement ______________________________ Type ______________

Pozzolan/Slag ______________________________ Type ______________

Fine Aggregate ______________________________ Type ______________

Coarse Aggregate ______________________________ Max. Size ______________

Admixtures ______________________________

QUANTITIES FOR 1 CUBIC YARD

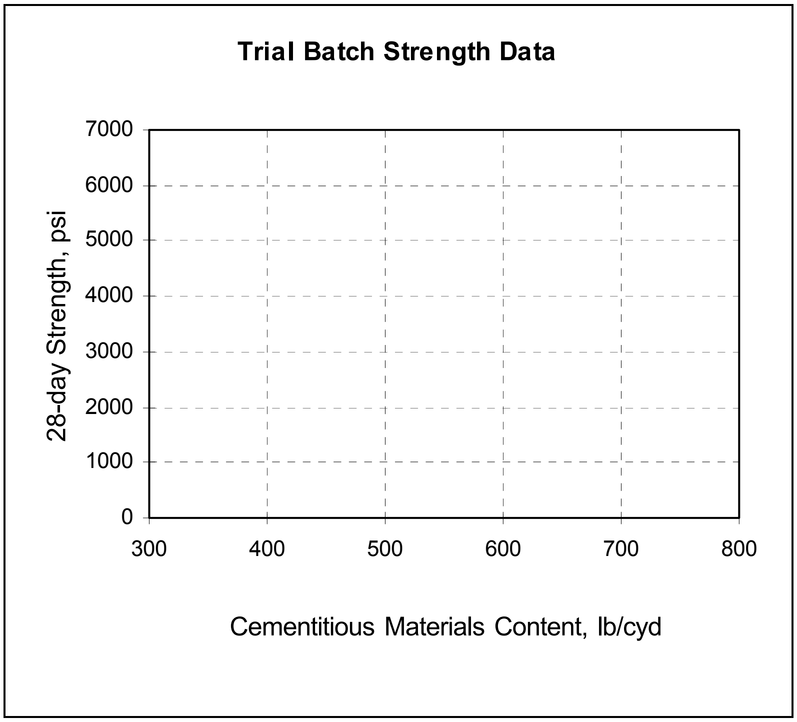
Material	No. 1	No. 2	No. 3	No. 4
Cement, lb.				
Fly Ash, lb.				
Mixing water, lb.				
SSD Sand, lb.				
SSD Gravel, lb.				
AEA, oz.				
Water reducer, oz				
w/cm ratio				

FRESH CONCRETE PROPERTIES

Batch Size, cu.ft.				
Air Temp., ^{o}F				
Concrete Temp., ^{o}F.				
Slump, inches				
Air Content, %				
Unit Weight, lb./cu.ft.				
Design Yield, cu.ft.				
Actual Yield, cu.ft.				

CONCRETE STRENGTH RESULTS, psi

7 day No. 1				
No. 2				
7-day Average				
28-day No. 1				
No. 2				
No. 3				
28-day Average				



Specified Strength, f'_c ___________________ psi

Specified Slump: _________________ inches   Specified Air Content: ____________%

Required average strength, f'_{cr} _____________ psi

Recommended cementitious materials content _____________ lb./cu.yd.

Recommended w/cm ratio _____________

Comments: ____

____

____

Signature: ____   Date: ____________________

Title: ____

SAMPLE SUBMITTAL FOR STRENGTH ACCORDING TO ACI 318 REQUIREMENTS

Company ______________________________

Past Project ______________________________

Mixture Identification ____________________ Specified Strength, f'_c __________ psi

Specified Slump: __________ inches Specified Air Content: __________%

Testing Period ____________________

SOURCE OF MATERIALS

Cement ______________________________ Type ______________

Fine Aggregate ______________________________ Type ______________

Coarse Aggregate ______________________________ Max. Size ______________

Admixtures ______________________________

SUMMARY OF STRENGTH TEST RESULTS (see over for test results)

Number of tests (n) __________

Average 28-day Strength ($\bar{X}$) __________ psi

Standard Deviation (S) __________ psi

Coefficient of Variation (V) __________ %

CALCULATION OF REQUIRED AVERAGE STRENGTH

New Project ______________________________

Mixture Identification ____________________

Specified Strength, f'_c __________ psi

Specified Slump: __________ inches Specified Air Content: __________%

Required Average Strength, f'_{cr} according to ACI 318

Eqn. 5.1 $f'_{cr} = f'_c + 1.34.S$ = __________ psi

Eqn. 5.2 $f'_{cr} = f'_c + 2.33.S - 500$ = __________ psi

Signature: ______________________________ Date: ______________

Title: ______________________________

DOCUMENTATION OF STRENGTH TEST RESULTS

Test No.	Date Tested	28-day Strength Test Results, psi			
		Cyl. 1	Cyl. 2	Cyl. 3	Average
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					
21					
22					
23					
24					
25					
26					
27					
28					
29					
30					
Average 28-day Strength, psi					
Standard Deviation, psi					

SAMPLE REPORT OF PLANT AND TRUCK INSPECTION

Company ____

Plant ______________________________ Inspection Date ________________

ITEMS INSPECTED	CHECK	BY	COMMENTS OR CORRECTIVE ACTIONS
CEMENTITIOUS MATERIALS SCALES			
Calibration	☐		
Maintenance tolerance	☐		
Visual inspection	☐		
Other ____________	☐		
AGGREGATE SCALES			
Calibration	☐		
Maintenance tolerance	☐		
Visual inspection	☐		
Other ____________	☐		
WATER BATCHING DEVICES			
Calibration	☐		
Batching accuracy	☐		
Other ____________	☐		
ADMIXTURE DISPENSERS			
Calibration	☐		
Batching accuracy and leaks	☐		
Other ____________	☐		
CENTRAL MIXER			
Visual inspection	☐		
Uniformity Tests	☐		
Other ____________	☐		
AGGREGATE STOCKPILES			
Visual inspection	☐		
Other ____________	☐		
CEMENTITIOUS MATERIAL BINS OR SILOS			
Visual inspection	☐		
Other ____________	☐		
CONVEYOR BELTS AND ROLLERS			
Visual inspection	☐		
Other ____________	☐		
AGGREGATE MOISTURE METERS			
Calibration	☐		
TRUCK BARRELS (LIST TRUCK NUMBERS)			
Visual inspection	☐		
Other ____________	☐		

Signature: ____________________ Title: ______________________________

NRMCA

SAMPLE QUALITY CONTROL REPORT - AGGREGATE GRADING

Company ____________________

Project ____________________

Fine Aggregate Sample

Original Weight						
Sieves		Individual		Pass	%	%
Pass	Ret. on	Wt.	%	Sieve	Pass	Ret.
3/8 in.	No. 4			3/8 in.		
No. 4	8			No. 4		
8	16			8		
16	30			16		
30	50			30		
50	100			50		
100	200			100		
200	Pan			200		
Total					FM	

No. 200 wash

Wt. before ________

Wt. after ________

Difference ________ Minus No. 200 (wet), % ________

Aggregate Source ________

Aggregate Type ________

Sampled by ________ Date ________

Sampling Location ________

Tested by ________ Date ________

Quantity represented

Comments ________

Coarse Aggregate Sample

Original Weight						
Sieves		Individual		Pass	%	%
Pass	Ret. on	Wt.	%	Sieve	Pass	Ret.
				2 in.		
				1 1/2 in.		
				1 in.		
				3/4 in.		
				1/2 in.		
				3/8 in.		
				No. 4		
				No. 8		
Total					FM	

No. 200 wash

Wt. before ________

Wt. after ________

Difference ________ Minus No. 200 (wet), % ________

Aggregate Source ________

Aggregate Type ________

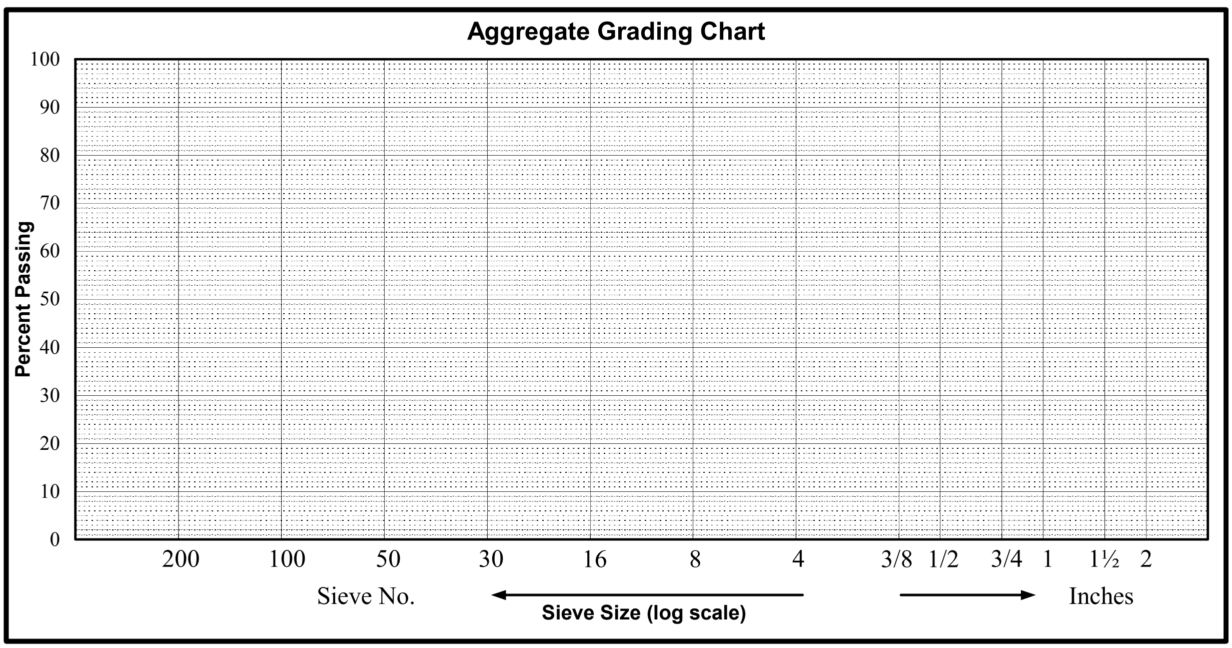
Sampled by ________ Date ________

Sampling Location ________

Tested by ________ Date ________

Quantity represented

Comments ________



Signature: ____________________ Date: ____________

Title: ____________________

SAMPLE QUALITY CONTROL REPORT - CONCRETE TESTS

Company ____

Project ____

Mixture Identification ____________________

Specified Strength, f'_c __________ psi

Required Average Strength, f'_{cr} __________ psi

Specified Slump: ____________ inches

Specified Air Content: __________%

Sampled by ____________________

Date Sampled ____________________

Truck No: ____________________

Location ____________________

FRESH CONCRETE PROPERTIES:

Slump ____________ in.

Air Content ____________ %

Concrete Temperature ____________ ºF

Ambient Temperature ____________ ºF

Yield Calculations:

Weight of Batch ____________ lb.

Concrete Unit Weight ____________ lb.

Yield ____________ yd^3

STRENGTH TEST RESULTS

AGE	CYLINDER 1	CYLINDER 2	CYLINDER 3	AVERAGE
1 day				
3 day				
7 day				
14 day				
28 day				

OTHER TEST DATA

____

____

____

OBSERVATIONS AND COMMENTS

____

____

____

Signature: ____________________ Title: ____________________

SAMPLE REPORT OF TRUCK DELIVERY ANALYSIS

Project ______________________________ Date ______________

Ticket No. __________ Truck. No.______________ Total Cubic Yards__________

Time Batched __________ Time Arrival at Job__________ Time Discharged __________

Time Sampled__________ Time Tested ______________

Sampled at ☐ End of Chute ☐ End of Pump Hose ☐ Other __________

Ambient Temp	Concrete Temp.	Air	Slump	Unit Weight

Number of Cylinders made ______________ Stored at ____________________

Notes and Comments ____

Signature ____________________

Ticket No. __________ Truck. No.______________ Total Cubic Yards__________

Time Batched __________ Time Arrival at Job__________ Time Discharged __________

Time Sampled__________ Time Tested ______________

Sampled at ☐ End of Chute ☐ End of Pump Hose ☐ Other __________

Ambient Temp	Concrete Temp.	Air	Slump	Unit Weight

Number of Cylinders made ______________ Stored at ____________________

Notes and Comments ____

Signature ____________________

SAMPLE REPORT OF WEATHER DATA

Project ______________________________ Date ______________

Project Location ______________________________________

Number of cubic yards ____________ Time of Placement ______________

TEMPERATURE RECORD

Midnt.______	6 a.m.______	Noon ______	6 p.m.______
1 a.m.______	7 a.m.______	1 p.m.______	7 p.m.______
2 a.m.______	8 a.m.______	2 p.m.______	8 p.m.______
3 a.m.______	9 a.m.______	3 p.m.______	9 p.m.______
4 a.m.______	10 a.m.______	4 p.m.______	10 p.m.______
5 a.m.______	11 a.m.______	5 p.m.______	11 p.m.______

High Temperature	____________	☐ Sunny	☐ Windy
Low Temperature	____________	☐ P. Cloudy	☐ Calm
Precipitation	____________	☐ Cloudy	

Forms for concrete placed on this date was stripped on ____________ at ______________

Curing for concrete placed on this date was stopped on ____________ at ______________

Other Information ______________________________________

____

____

____

Signature ____________________

Sample Report of Jobsite Analysis

Project ______________________________ **Contractor** ____ **Mix ID** __________________

Date	Truck	Tkt.	Cubic Yards	Time					Ambient Temp.	Sampled at	Concrete Properties					Comments
				Dispatch	Job-site arrival	Start Discharge	End Discharge	Excess Time			Temp.	Slump	Air	Unit Wt.	No. Cyls.	

Sample Report of Material Inventory

Project ______________________ **Contractor** ______________________

Cubic Yards ________ **Materials Required, tons: Cement** ________ **Fly Ash** ________ **Sand** ________ **Stone** ________

Date	Cubic Yards	Mix ID	Description	Material Used, tons				Restock, tons				Inventory on Hand, tons				Comments
				Cement	Fly Ash	Sand	Stone	Cement	Fly Ash	Sand	Stone	Cement	Fly Ash	Sand	Stone	