STATE OF OHIO
DEPARTMENT OF TRANSPORTATION
SUPPLEMENTAL SPECIFICATION 898

QC/QA CONCRETE FOR STRUCTURES
July 21, 2006

898.01 Description. This work consists of designing a concrete mix, providing an acceptable quality control plan, performing quality control sampling and testing, performing quality assurance testing.

The Department will use the results of the Contractor's acceptance testing to establish final pay factors, 898.15, and to calculate final payment under Basis of Payment, 898.17.

Use provisions of 511.08 thru 511.22 and 499.06 thru 499.09 except as modified by this specification or the Contractor's approved quality control plan. Place and cure all superstructure concrete according to the Class HP requirements.

898.02 Definitions And Referenced Specifications.

ACI	American Concrete Institute
AMRL	AASHTO Materials Reference Laboratory
Acceptance Tests	Compressive strength and plastic air tests that are the contractor's responsibility to obtain samples, make specimens and have tested. These test results are used for payment.
Arithmetic Mean ($\bar{x}$)	The value obtained by adding individual values and dividing by the number of individual values to obtain an average.

Certified Laboratory	An AMRL - PCC accredited laboratory
$f'c$	Specified Design Strength at 28 days.
$f'cr$	Required average compressive strength at 28 days (ACI 301 4.2.3.3)
Lot	The total cubic yards (cubic meters) required in the structure of the same class of concrete.
OMM	ODOT Office of Materials Management
Pay Factor	A numerical value established, based on the final quality, as an adjustment to the Contractor's final payment per bid item.
Permeability	A measurement of the concrete's resistance to the penetration of chloride ions. Tested according to AASHTO T277, as modified herein to approximate 90 day results. The value is reported in coulombs.
QA	Quality Assurance
QA Samples	Quality Assurance samples of concrete taken by the Department to verify results from the contractor's quality control and acceptance tests.
QC	Quality Control
QCP	Quality Control Plan
QC Samples	Quality Control samples taken by the contractor, or designee, in order to control the materials and processes and insure the delivery of concrete that meets this specification. May also include acceptance samples.
Standard Deviation (Sc)	The positive square root of the square of the difference between an individual sample value and the mean of the sample.
Sublot	Division of a Lot into 3 or more segments for the purpose of evaluating uniformity and consistency. For this specification, a sublot is defined as 50 cubic yards (40 cubic meters).
Substructure Concrete	Concrete used in the following bridge components: abutments, piers, footings, wingwalls, columns, pier caps, intermediate diaphragms between prestressed I-beams, cast-in-place piles and backwalls.
Superstructure Concrete	Concrete used in the following bridge components: Decks supported on steel or concrete beams, girders or box sections; slab bridge decks; abutment and pier diaphragms encasing prestressed I-beam or box beam members; abutment diaphragms encasing steel beams or girders; approach slabs; sidewalks; and deflector parapets.
Unacceptable material	Concrete which is placed but fails to meet strength or air content requirements.

Referenced Specifications:

ACI 301	Standard Specification for Structural Concrete
ASTM C31	Method of Making and Curing Concrete Test Specimens in the Field
ASTM C39	Test Method for Compressive Strength of Cylindrical Concrete Specimens
ASTM C42	Method of Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
ASTM C94	Standard Specification for Ready-Mixed Concrete

ASTM C143	Test Method for Slump of Portland Cement Concrete
ASTM C172	Method of Sampling freshly Mixed Concrete
ASTM C173	Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method
ASTM C231	Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C989	Standard Specification for Ground Granulated Blast-Furnace Slag for use in Concrete and Mortars
ASTM C1064	Standard Test Method for Temperature of Freshly Mixed Portland Cement Concrete
ASTM C1240	Standard Specification for Silica Fume for use as a Mineral Admixture in Hydraulic Cement Concrete, Mortar and Grout
AASHTO T277	Standard Test Method for Electrical Indication of Concrete's Ability to Resist Chloride Ion Penetration - modified by this specification

898.03 Materials.

Coarse aggregate.....703.02

1. Use sizes No. 8, 78, 7, 67, 57 either alone or in combination.
2. The maximum sodium sulfate soundness loss shall be 12 percent.
3. Unless approved by the Engineer, use the same kind and color of aggregates for all concrete above the ground line in a given substructure or superstructure unit.

Fine aggregate.....703.02
Portland cement ..... 701.01, 701.02, 701.04, 701.05 or blended cements*
Fly ash 701.13
Ground granulated blast furnace slag 701.11
Micro-silica.....701.10
Air-entraining admixture 705.10
Chemical admixtures 705.12
High Molecular Weight Methacrylate Resin 705.15
Curing materials.....705.05, 705.06 (white opaque) 705.07 type 1 or 1D
Joint filler - 1/4 (6 mm) ..... 711.28 or 705.03
Seals (preformed elastomeric compression joint).....705.11

* Obtain OMM approval before using blended cements. The ready-mix plant shall certify blended cements. Blended cements shall have specific defined limitations on percentages of blended materials and shall be comprised of components that meet the applicable specifications.

Document and report changes in the source(s) of cement, fly ash or GGBF slag to the Engineer. Store bulk fly ash or GGBF slag in waterproof bins.

Provide a technical representative from either the admixture company or the concrete supplier to be in charge of dispensing admixtures. The representative shall act in an advisory capacity reporting to the Contractor and the Engineer any operations or procedures considered to be detrimental to the integrity of the concrete. The technical representative shall be present during concrete placement

unless waived by the Contractor.

898.04 Water. Provide water free of sewage, oil, acid, strong alkalis, vegetable matter, clay or loam. Water shall conform to ASTM C94. Concrete produced with either wash water or storm water shall use a reclaiming system monitoring the quality of the water to meet ASTM C94 and produce no more than 0.06% total chlorides by weight of cement into the concrete. The Department will approve the reclaiming system.

898.05 Concrete Mix Design. Develop concrete mix designs according to ACI 301, section 4, and as modified in this specification. Submit test data from a Certified Laboratory to the OMM.

Establish the maximum air content for the concrete mix design and produce concrete within 0.5% of that maximum for the submitted data. If the test values meet the requirements of this specification, this value becomes the maximum air content for the mix design and for acceptance at the project.

The Certified Laboratory shall mix the trial batch, sample and test the samples (ACI 301, 4.2.3.4.b). An ACI Grade I Technician may perform batching and sampling with the laboratory witnessing the process. The certified laboratory shall perform the compressive strength and permeability testing.

Determine the required average compressive strength (f'cr) according to ACI 301, section 4.2.3. If there is no field data available, select the over-design of the mix from ACI 301, Table 4.2.3.3b. Follow ACI 301 section 4.2.3.4.a., or 4.2.3.4.b when using field or laboratory data, respectively, to establish a mix design. Use field test data from previous ODOT projects under this specification or other sources approved by the OMM.

If the laboratory trial mix procedure is used to support the mix design, a single mix can be prepared, but it shall meet all of the requirements of this specification. Produce the trial mix using the maximum water and all admixtures required to achieve the maximum placement slump and maximum air. Record the slump and air, and produce the strength and permeability test samples from the same mix.

Use a cement or cementitious content meeting the minimums given in **TABLE 3**.

TABLE 1

CONCRETE MIX DESIGN REQUIREMENTS			
Concrete Use (Class)	Specified Compressive Strength (f'c) psi (MPa)	Design Permeability (P_d) ** Coulombs	Plastic Air Content %
Substructure(QSC1)	4000 (28.0)	< 2000	TABLE 2
Superstructure(QSC2)	4500 (31.0)	< 1500	TABLE 2
Project Specific(QSC3)	As per plan	As per plan	TABLE 2

** Determine the design permeability values by testing in conformance with AASHTO T-277 except as modified as follows: Moist cure permeability samples for 7 days at 73° F (23°C) followed by 21 days of moist curing at 100° F (38°C). Perform permeability testing at 28 days.

TABLE 2

AIR CONTENT LIMITATIONS				
	Design	AT POINT OF PLACEMENT	AT POINT OF DISCHARGE WHEN PUMPING CONCRETE	AT POINT OF SAMPLING FOR ACCEPTANCE
Aggregate Size	Design Air	Minimum Air	Minimum Air	Maximum Air
8, 7, 78	7%	5.0%	6.0%	Established by the Producer as tested for each mix design
67, 57	6%	4.0%	5.0%	

Blending coarse aggregate is acceptable. Report the production blend.

TABLE 3

CONCRETE MIX DESIGN LIMITATIONS	
Minimum Cementitious Content *	565 lbs/yd^3 (335 kg/m^3)
Fly Ash	up to 25%
Ground Granulated Blast Furnace Slag	up to 30%
Micro-Silica	up to 10%
The total combination of pozzolan materials shall not exceed their individual percentage nor total more than 50% of the total cementitious content	

* The cementitious content shown above is a minimum. The Contractor is responsible for proportioning a mix that is workable and meets all of the requirements of this specification. To accomplish this, quantities above the minimum shown may be required.

898.06 Mix Design Documentation. Mix designs for each class of concrete required on the project shall include certified test data documenting results for the following:

- Design Air Content
- Maximum Air Content
- Compressive Strength
- Slump
- Unit Weight
- Yield
- Aggregate Correction Factor
- Specified Design Strength (*f'c*)
- Required Over- Design Value
- Permeability

Also include:

TABLE 4

Mix Design Batching Data					
Material	**Design Weight (SSD)**	**Source**	**Type**	**Specific Gravity**	**Absorption (%)**
Fine Aggregate	Required	Required	Required	Required	Required
Coarse Aggregate 1	Required	Required	Required	Required	Required
Coarse Aggregate 2	Required	Required	Required	Required	Required
Cement *	Required	Required	Required	Required	Not Applicable
Fly Ash	Required	Required	Required	Required	Not Applicable
GGBF	Required	Required	Required	Required	Not Applicable
Micro-silica	Required	Required	Required	Required	Not Applicable
Other	Required	Required	Required	Required	Not Applicable
Water	Required	Required	Not Applicable	Not Applicable	Not Applicable

Admixtures	**Type**	**Brand Name**	**Dosage Rate**
Admixture 1	Required	Required	Required
Admixture 2	Required	Required	Required
Admixture 3	Required	Required	Required
Admixture 4	Required	Required	Required
Water/Cementitious Ratio	Required		

* If a blended cement is used, indicate the components of the blended cement and the proportions of those components.

Changing sources of materials from those tested for the design submittal may require retesting of the mix for acceptance. The Department will request certification that the source changes will not adversely affect the tested mix. The Department will require retesting when changing aggregate type; aggregate size; cement type; and pozzolan type or grade.

Test any workability issues in the trial process. The Department will require a new mix and retesting for unworkable mixes in the field. The Department will consider modifying aggregate weights by more than 3%, excluding adjustments for specific gravity or absorption changes, as a change to the mix design.

898.07 Mix Design Acceptance. Submit one copy of the mix design and test data to the OMM at least 10 calendar days prior to placement. The OMM will review the mix design to ensure that the design parameters in **TABLE 1** are met; limitations in **TABLES 2** and **3** are not exceeded; and the design batching data in **TABLE 4** is included.

Also submit a copy of the mix design data to the Engineer. The Engineer will review the mix design for compliance with the plan requirements and for project information and control. Do not place concrete until the mix design has been accepted.

898.08 Lot, Sublot And Random Load Determination For Strength And Permeability Acceptance.

Use a single mix design for each lot.

Provide the Engineer with a proposed placement schedule and division of the concrete lot into a minimum of 3 sublots. The maximum size of each sublot shall be 50 yd^3. The Engineer will approve the sublot divisions. Use a sequential numbering system for lots and sublots (i.e. Lot 1: sublot 1, sublot 2, etc).

The Engineer will determine the random load from which the Contractor will sample the concrete to perform acceptance testing as required in 898.15 as follows:

The Engineer will:

1. Randomly choose a starting number from **TABLE 7**.
2. Multiply the starting number by the volume of the first sublot and round to the nearest whole number to determine an individual yardage. The Contractor shall sample the load containing this individual yardage.
3. Determine the individual yardage and load to be sampled for the next sublots using the next sequential number in the random number table and repeating step 2 until all sublots for the given class of concrete are complete.
4. Inform the Contractor of the sublot test locations at the beginning of the day's placement.

898.09 Contractor Quality Control Plan. Develop a QCP establishing the responsibilities, duties and frequency of quality control testing for both in-process quality control at the job site and at the concrete's source. Use either a certified laboratory to perform all quality control responsibilities or perform some of the sampling and testing with an ACI certified Grade 1 Field Testing Technician. The person performing the quality control testing shall immediately inform the Contractor and Engineer of non-compliant test results before the load of concrete is rejected, retempered or discharged.

Use a certified lab to test compression samples used to establish pay factors (898.15) and test QA samples (898.11).

Include with the QCP: **TABLE 10** for reporting plastic air acceptance results and **TABLE 9** for reporting compressive strength. The Engineer will establish documentation for other items, such as core results for in-place evaluation, if needed.

Submit a complete QCP to the Engineer for review and acceptance with the mix design submission. Include at least the following information:

1. The name of the certified laboratory. (Include AMRL accreditation)
2. Name and certification of all laboratory, and/or Contractor's, technicians who will perform plant and/or field site sampling and testing. (Minimum: ACI Grade1 Field Testing Technician certification)
3. Method of reporting test results for compressive strength and plastic air (minimum requirements: The certified laboratory shall furnish and certify all results using the QC/QA reporting forms, **TABLES 9** and **10**)

4. Test equipment calibration records
5. Method for field curing specimens
6. Methods for transporting samples to the certified laboratory
7. Certified laboratory curing procedures.
8. In-process quality control program establishing the method of:
   (a) Raw materials certification and control
   (b) Aggregate moisture controls performed at least daily
   (c) Concrete delivery controls.
   (d) Minimum required rate of concrete delivery for continuous placement
   (e) Concrete plant controls
   (f) Construction site controls
   (g) Methods for curing and testing samples for form release/removal - See 898.12.
   (h) Concrete placement procedures, equipment, finishing methods, curing methods, lighting, etc.
   (i) Methods of protecting concrete if inclement weather or evaporation rate exceeds specification requirements
9. Proposed modifications to construction processes of 511 and 499.

Address, in the QCP, whether plant control includes quality control personnel monitoring the mixing process. Use the NRMCA Publication No 190, NRMCA Guideline Manual for Quality Assurance/Quality Control, as one possible source to model the Quality Control Plan.

Provide delivery tickets conforming to 499.08.

Establish the desired slump for each item and maintain that slump within ±1½ inches (38mm). Measure the slump when performing the air and compression testing (898.10) to verify consistent results within the specified tolerance. If slump loss occurs before placement, replasticize with either water, if the maximum water/cementitious ratio is not exceeded, or an admixture to restore plasticity. Recheck the air content. Reject any loads that segregate.

898.10 Contractor Quality Control (QC) & Acceptance Testing.

Perform air content QC testing at the point of discharge from the Ready Mix concrete truck. Use the following quality control procedures during the placement:

1. Test the air content on at least the first three (3) loads of concrete delivered for each day's placement. Ensure that the air content is stabilized and within the specified parameters for the mix design before extending the sampling and testing frequency.

2. Once the air content is stabilized to the Engineer's satisfaction, extend the sampling frequency to no more than one test for every three (3) loads of concrete delivered.

   If a load of concrete is tested and found to have an air content less than the minimum in TABLE 2 or above the maximum air established for the mix, do not accept and place that load unless it can be adjusted to be within the specified limits. Test at least the next three loads for air to ensure that the air content is stabilized to the Engineers satisfaction. The sampling frequency may then be extended back to one test for every three (3) loads of concrete delivered.

3. For concrete delivered to the point of placement by means of pumping equipment,

provide a hose at the end of the line that is at least ½" in diameter smaller than the line on the boom to provide back pressure in the system and minimize the amount of air lost in the concrete.

During the first three loads, test the concrete at the point of discharge and the point of placement to verify that the loss of air going through the pump does not exceed 1%. If the amount of air loss is not controlled to the Engineer's satisfaction, make adjustments to the pump setup that results in an air loss of less than 1%. If less than 1% loss can not be achieved, test the air at the point of placement on every load and use the air limits for the point of placement in **TABLE 2**.

Placing concrete indirectly into the forms by a method other than pumping requires a similar evaluation of the air and appropriate controls to limit losses.

4. Use methods to produce back pressure in the system other than the ½" diameter smaller hose upon approval of the Engineer. Provide a trial placement of concrete, at the most severe condition, using the proposed method to prove to the Engineer's satisfaction that the method has acceptable air loss at the extreme position of the pump.

5. Provide the Engineer a signed copy of the plastic air results **(TABLE 10)** after each placement.

Any concrete with an air content above the maximum air or below the minimum air that is placed into the structure is unacceptable material for the amount of material represented by the sampling frequency. Incentives according to 898.15 will not apply to unacceptable material. In accordance with CMS 106.07, test unacceptable material as follows:

1. For high air, core and test unacceptable material according to 898.14. Unacceptable material with sufficient strength may be left in place.

2. For low air, take at least one (1) core for each represented load in the area where the unacceptable material was placed. Perform a petrographic analysis according to ASTM C457. Remove and replace unacceptable materials with a specific surface less than 600 in^2/in^3 and a spacing factor of more than 0.008 in. The Department will not permit the same private laboratory performing the QC testing to perform the petrographic analysis. The Department will not pay for the petrographic analysis.

Perform the following quality control/acceptance sampling and testing for compressive strength from the load determined by the random number:

1. Sample each sublot by making one (1) set of three (3) - 6"x12" (150x300mm) quality control/acceptance compressive strength cylinders. Test two (2) of the cylinders at 28 days. If the results are within the acceptable range established in ASTM C39 – Section 10, report the two results and the average as the strength for the sublot and discard the third cylinder. If the results of the first two cylinders are not within the acceptable range of ASTM C39 – Section 10, test the third cylinder and average the two closest results and report as the strength for the sublot.

Perform all required curing, transporting, capping and testing of the samples to conform

to the applicable ASTM specifications. Report the actual test values for quality control/acceptance using **TABLE 9**. If developing a maturity curve, provide the maturity curve to the Engineer prior to placement or removal of the falsework.

2. Determine the concrete temperature according to ASTM C1064 from the same sample taken for compressive strength. Ensure compliance with 499.09 and 511.15.

Sample the concrete at the point of discharge unless the air is being tested at the point of placement as required by 898.10-3

Provide strength results within 5 days of completion of test.

If the quality control person(s) fails to follow proper testing procedures; use adequate equipment; inform the Contractor and Engineer of unacceptable material; or report results in a timely manner, the Engineer may have the quality control person(s) and/or company removed from the project and suspend work until an acceptable replacement can be provided.

898.11 ODOT Quality Assurance. ODOT will perform QA sampling and testing as specified or as deemed necessary.

The Department will perform side by side testing with the Contractor and compare results. If the difference between the Department's and the Contractor's testing is greater than the tolerances listed below, the Contractor and Engineer will determine the reason for slump or air content differences and make necessary adjustments. The Engineer may stop the placement until the reason for the difference is established and corrected. The Engineer will check one of the first three loads delivered. Once the results are within the tolerances listed below, the Engineer may reduce the QA sampling and testing frequency to 10% of the Contractor's subsequent quality control/acceptance tests.

1. Slump - ± 1 inch (25 mm)
2. Air Content - ± 1%.

The Engineer will obtain compressive strength QA samples from the same location as the Contractor's quality control/acceptance samples. The Engineer will obtain QA samples for every 10 sublots or at least one per lot. The Engineer will make four (4) - 6" x 12" (150 x 300 mm) cylinders for each sample. The Engineer will mark the cylinders with identification and the Contractor shall take ownership for handling, shipping, curing, transporting and testing the specimens.

After fourteen (14) days curing, deliver two (2) of the QA cylinders to the ODOT Office of Materials Management at 1600 W. Broad Street, Columbus, OH during normal working hours. Continue to cure the other two (2) QA cylinders with the quality control/acceptance cylinders at the Certified Laboratory. The Certified laboratory shall test the two (2) QA cylinders with the quality control/acceptance cylinders and report the 28 day test results on the accepted QCP form. The report shall distinguish the QA cylinder results from the quality control/acceptance results, including the sublot.

The Engineer will verify that the Department tested QA, Contractor tested QA and the matching quality control/acceptance test results are within 500 psi (3.9 MPa). Investigate the results with the Engineer to determine the reason for the difference greater than 500 psi (3.9 MPa). If no reason is

determined, the Engineer will require the Contractor to either non-destructively test or core the concrete represented by the cylinder tests to determine compressive strength. Hire an independent laboratory to perform this additional testing. The Engineer will witness the testing and evaluate the results. The Department will reimburse the Contractor for all testing costs when the Department's results are in error. If found valid, use the cylinder acceptance results, or if cores were taken during the evaluation, use the core's test results to determine the compressive strength values for pay factors, 898.15.

The Engineer will reject a mix design when a single compressive strength quality control/acceptance test result drops below 88% of *f'c* or a lot of concrete has a Percent Acceptable Material, 898.15, below 75. If the mix design is rejected, develop a new mix design according to 898.03 and 898.05.

The Engineer will reject loads and stop placement when quality control processes do not control balling, segregation, inconsistent or variable concrete indicating poor quality control. Do not restart placement until the cause of the problem is determined and corrected.

898.12 Curing And Loading. Perform all testing required in this section as part of the quality control program. Modify 511.17 as follows:

Do not use the falsework removal and traffic loading Table 511.17-1. Do not remove falsework for structure concrete, QSC1, QSC2 or QSC3, or subject it to construction or erection loads until field cured compressive strength test cylinders or maturity results reach a strength of 85% of *f'c* or greater. If using flexural beams, obtain a center-point Modulus of Rupture of 650 psi (4.6MPa) or greater before opening to traffic. Remove formwork according to 511.16. Do not shorten the minimum required Method A curing time regardless of strength test results. Allow formwork construction and placement of reinforcing steel if no motorized equipment applies loads to the concrete and field cured compressive strength is 60% of *f'c*.

Make additional compressive or flexural samples required to verify compliance with the strengths above. The Contractor may use maturity testing according to Department standards to determine the in-place strength of the concrete.

The Department will not approve time extensions to the project completion date for delays caused by slow strength gain of the concrete.

898.13 Slipforming. Follow 511.11 except:
Reducing the established water /cementitious ratio or amount of admixture of an approved mix to achieve the desired consistency will not require a new mix design. The Department will require separate mix designs conforming to 898.05 for adjustments to the mix beyond those permitted in 898.06. The Department will permit designating slipformed concrete as a separate lot.

898.14 Reevaluation Of Strength.

A. If a single compressive strength acceptance test result for a sublot of concrete is less than 88% of the specified *f'c,* the Engineer will evaluate and accept or reject the material, at no cost to the Department, as follows:

   The Engineer will determine the location for evaluating the strength of the sublot represented by the low compressive strength. Evaluate using either nondestructive testing or cores. Nondestructive testing may be used only to determine if further action is necessary. The

Engineer will accept the concrete if nondestructive test results are greater than the specified $f'c$. Use the original cylinder results for calculating the compressive strength pay factor (PF_c) only if further testing confirms the original cylinder results are accurate. If further testing confirms the original results are not accurate, the Engineer will not use the original cylinder results or the sublot for determining the pay factor. The Department will require coring if the nondestructive test results are less than the specified $f'c$.

Core the concrete at locations determined by the Engineer. Provide the cores to the Engineer for testing by the Department. Patch core holes with approved patching material. Base the final payment of the sublot and lot on the core strength results. If the core results indicate that the compressive strength of the concrete is below 88% $f'c$, submit a plan for corrective action to the Engineer for approval. If the corrective plan is not approved, the Engineer will require the Contractor to:

1. Remove and replace the unacceptable sublot at no cost to the Department, or
2. Leave the unacceptable material in place and pay for the sublot with a pay factor of 0.75.

B. If the Percent Acceptable Material, 898.15, for a lot of concrete is below 75%, submit a plan for corrective action to the Engineer for approval. If the corrective plan is not approved, the Engineer will require the Contractor to:

1. Remove and replace the lot of unacceptable material at no cost to the Department, or
2 Leave the unacceptable material in place and pay for the lot of with a pay factor of 0.75.

898.15 Pay Factor Determination. The Department will use pay factors (PF) to establish a final adjusted price, per lot, for each bid item quantity of concrete. The Department will calculate pay factors using the Contractor's quality control/acceptance test results, per lot. The Department will calculate a compressive strength pay factor (PF_c) for each lot.
The Department will determine PF_c as follows:

Determine arithmetic mean ($\bar{x}$) for compressive strength using the following formula:

$$\bar{x}=(\sum x)/n$$

x = Test values
n = Total number of test values in each lot

Determine, for each lot, the sample standard deviation for compressive strength (S_c). Use the following formula:

$$S_c = [\sum(x - \bar{x})^2 / (n-1)]^{½}$$

x = Individual test value
n = Total number of compressive strength sublot values in each lot
$\bar{x}$ = Arithmetic mean of individual test values in each lot

Determine the compressive strength quality index (Q_{LLC}) for each lot. Use the following formula:

$$Q_{LLC} = (\bar{x} - f'c)/S_c$$

Round the Q_{LLC} value to the nearest 0.01. Using the Q_{LLC} value, enter **TABLE 8** and determine the percentage of unacceptable material for compressive strength (PD_c). Do so by first choosing the correct table based on the number of samples; Then determine the correct row by matching the whole number and first number after the decimal of the Q_{LLC}; finally determine the correct column by matching the second number after the decimal of the Q_{LLC}. Calculate the Percent Acceptable Material by subtracting the PD_c from 100%.

$$\text{Percent Acceptable Material} = 100 - PD_c$$

Determine the PF_c for the mix design lot using **TABLE 5** (See example)

TABLE 5

COMPRESSIVE STRENGTH	
Percent Acceptable Material	PF_c Pay Factor
98.0 – 100%	1.04
95 – 97.9%	1.02
85 – 94.9%	1.00
75 – 84.9%	.95
Below 75%	See 898.14

898.16 Method Of Measurement. The Department will measure the appropriate concrete item by the number of cubic yards (cubic meters) determined by calculations from plan dimensions, in place, completed and accepted. The Department will not make deductions for volume of reinforcing steel, conduits, or structural steel other than beam flanges embedded in deck slabs. The Department will not make deductions for the volume of embedded timber or concrete piles.

The Department may measure deck concrete by either volume or area using plan dimensions.

Superstructure concrete includes the concrete in deflective parapets not having a metallic railing.

The Department will calculate separate quantities of unacceptable material due to air content, 898.10 and compressive strength 898.14.

898.17 Basis Of Payment. The Department will pay for accepted quantities as follows:

The Department will not pay for the reevaluation of low strength test results, 898.14

The Department will not make separate payment for surface finish or sawing grooves in the deck. All costs are incidental to the appropriate concrete item.

The Department will initially pay the full bid price to the Contractor upon completing the work.

The Department will calculate the final adjusted payment for each item as follows:

PF_1 The final adjusted pay per cubic yard (meter) or square yard (meter), per item. Apply only to quantities of concrete placed determined to not be unacceptable according to 898.10 or 898.14.

$$PF_1 = (\text{Contract Bid Price}) \times PF_c$$

PF_2 The final adjusted pay per cubic yard (meter) or square yard (meter) for the quantity of concrete placed in an item that contains unacceptable concrete based on compressive strength and allowed to stay in place, according to 898.14

$$PF_2 = (\text{Contract Bid Price}) \times 0.75$$

Calculate the adjusted price per bid item by multiplying PF_1 or PF_2 by the appropriate quantities of concrete, then sum the values. Subtract the full bid price paid to the contractor from the adjusted price to determine the difference. The Department will execute final adjustments by change order upon receipt of all test data.(See example)

Item	**Units**	**Description**
898	Cubic yard (cubic meter)	QC/QA concrete class ____ _____
898	Cubic yard (cubic meter)	QC/QA concrete class QSC2 superstructure (deck)
898	Square yard (square meter)	QC/QA concrete class QSC2 superstructure (deck)
898	Cubic yard (cubic meter)	QC/QA Concrete class QSC2 superstructure (parapet)
898	Cubic yard (cubic meter)	QC/QA Concrete class ____ superstructure
898	Cubic yard (cubic meter)	QC/QA Concrete class QSC1 substructure ____

Compressive Strength Example: A 420 yd^3 bridge deck using QSC2 concrete is placed. There are 8 sublots @ 50yd^3 and1 sublot @ 20 yd^3 for the lot. The compressive strength acceptance test results are as follows: 5060, 5820, 5210, 5930, 5740, 6130, 6560, 5040 and 7080 psi.

1. Calculate the Average Strength and Standard Deviation (S_c) as follows* :

SAMPLE	COMPRESSION (X)	$X - \bar{x}$	$(X - \bar{x})^2$
1	5,060	-781	609,961
2	5,820	-21	441
3	5,210	-631	389,161
4	5,930	89	7,921
5	5,740	-101	10,201
6	6,130	289	83,521
7	6,560	719	516,961
8	5,040	-801	641,601
9	7,080	1239	1,535,121
Total	52,570	0	3,803,889
Avg. ($\bar{x}$)	**5,841**		

Formula: $\mathbf{S_c = [\Sigma(x - \bar{x})^2 / (n-1)]^{½}}$

$= [3,803,889 / (9-1)]^{½}$

$= [3,803,889 / 8]^{½}$

$\mathbf{S_c = 690}$

* This can also be calculated using standard computer programs. Make sure that the **Sample Std Dev** is used rather than the **Population Std Dev**.

2. Calculate the Quality Index (Q_{LLC}):

Formula: $\mathbf{Q_{LLC} = (\bar{x} - f'c)/S_c}$

$= (5,841 – 4,500) / 690$

$= 1,341 / 690$

$= \mathbf{1.94}$

3. Determine the Percent Defective (PD_c) and then Percent Acceptable Material:

Go to **TABLE 8**; n = 9; Q_{LLC} = 1.94 (1.9 on the column on the left side of the table and 0.04 across the top row)

% Defective = 1.32, therefore

Percent Acceptable Material = 100 - 1.32 = **98.68 %**

4. Go to **TABLE 5** to determine the compressive strength Pay Factor **(PF_c) = 1.04** @ 98.68%

Applying Pay Factors for Final Payment example:

Bid Price	\$325.00 / yd^3
Quantity	420 yd^3
Amount paid to Contractor upon completion of work	325.00 x 420 =\$136,500.00
Total payment owed to Contractor due to pay factors (PF_1)	325 x 420 x1.04 =\$141,960.00
Amount of additional money owed to contractor via change order	\$141,960 - \$136,500.00 = +\$5,460.00

TABLE 7

RANDOM NUMBERS					
0.889	0.848	0.612	0.806	0.774	0.115
0.745	0.127	0.317	0.867	0.645	0.212
0.697	0.138	0.236	0.447	0.651	0.436
0.123	0.326	0.775	0.467	0.419	0.725
0.807	0.121	0.369	0.778	0.796	0.570
0.653	0.529	0.688	0.887	0.449	0.419
0.524	0.161	0.899	0.155	0.526	0.722
0.192	0.897	0.798	0.244	0.205	0.180
0.654	0.174	0.133	0.262	0.380	0.828
0.127	0.796	0.608	0.102	0.428	0.194
0.615	0.385	0.102	0.782	0.589	0.113
0.333	0.309	0.692	0.559	0.860	0.421
0.562	0.497	0.210	0.220	0.592	0.850
0.346	0.789	0.523	0.368	0.716	0.193
0.564	0.621	0.804	0.641	0.183	0.351
0.649	0.521	0.850	0.189	0.332	0.736
0.403	0.510	0.562	0.670	0.881	0.723
0.792	0.203	0.318	0.608	0.107	0.572
0.454	0.682	0.521	0.588	0.141	0.110
0.703	0.634	0.846	0.826	0.475	0.313

TABLE 8: Estimated percent defective for compressive strength (PDc)
Sample size (n) = 2

Q	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0.0	50.00	49.66	49.33	48.99	48.66	48.32	47.99	47.65	47.32	46.98
0.1	46.64	46.31	45.97	45.64	45.30	44.97	44.63	44.30	43.96	43.62
0.2	43.29	42.95	42.62	42.28	41.95	41.61	41.28	40.94	40.60	40.27
0.3	39.93	39.60	39.26	38.93	38.59	38.26	37.92	37.58	37.25	36.91
0.4	36.58	36.24	35.91	35.57	35.23	34.90	34.56	34.23	33.89	33.56
0.5	33.22	32.89	32.55	32.21	31.88	31.54	31.21	30.87	30.54	30.20
0.6	29.87	29.53	29.19	28.86	28.52	28.19	27.85	27.52	27.18	26.85
0.7	26.51	26.17	25.84	25.50	25.17	24.83	24.50	24.16	23.83	23.49
0.8	23.15	22.82	22.48	22.15	21.81	21.48	21.14	20.81	20.47	20.13
0.9	19.80	19.46	19.13	18.79	18.46	18.12	17.79	17.45	17.11	16.78
1.0	16.44	16.11	15.77	15.44	15.10	14.77	14.43	14.09	13.76	13.42
1.1	13.09	12.75	12.42	12.08	11.75	11.41	11.07	10.74	10.40	10.07
1.2	9.73	9.40	9.06	8.72	8.39	8.05	7.72	7.38	7.05	6.71
1.3	6.38	6.04	5.70	5.37	5.03	4.70	4.36	4.03	3.69	3.36
1.4	3.02	2.68	2.35	2.01	1.68	1.34	1.01	0.67	0.34	0.00

For values of Q greater than or equal to zero, the estimate of percent defective (PDc) is read directly from the table. For values of Q less than zero, the table value must be subtracted from 100. Values of Q greater than what is on the table indicate that there is 0.00 % unacceptable material.

TABLE 8 (CONT.): Estimated percent defective for compressive strength (PDc)
Sample size (n) = 3

Q	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0.0	50.00	49.72	49.45	49.17	48.90	48.62	48.35	48.07	47.79	47.52
0.1	47.24	46.96	46.69	46.41	46.13	45.85	45.58	45.30	45.02	44.74
0.2	44.46	44.18	43.90	43.62	43.34	43.05	42.77	42.49	42.20	41.92
0.3	41.63	41.35	41.06	40.77	40.49	40.20	39.91	39.62	39.33	39.03
0.4	38.74	38.45	38.15	37.85	37.56	37.26	36.96	36.66	36.35	36.05
0.5	35.75	35.44	35.13	34.82	34.51	34.20	33.88	33.57	33.25	32.93
0.6	32.61	32.28	31.96	31.63	31.30	30.97	30.63	30.30	29.96	29.61
0.7	29.27	28.92	28.57	28.22	27.86	27.50	27.13	26.76	26.39	26.02
0.8	28.64	25.25	24.86	24.47	24.07	23.67	23.26	22.84	22.42	21.99
0.9	21.55	21.11	20.66	20.19	19.73	19.25	18.74	18.25	17.74	17.21
1.0	16.67	16.11	15.53	14.93	14.31	13.66	12.98	12.27	11.51	10.71
1.1	9.84	8.89	7.82	6.60	5.08	2.87	0.00	0.00	0.00	0.00

For values of Q greater than or equal to zero, the estimate of percent defective (Pdc) is read directly from the table. For values of Q less than zero, the table value must be subtracted from 100. Values of Q greater than what is on the table indicate that there is 0.00 % unacceptable material.

TABLE 8 (CONT.): Estimated percent defective for compressive strength (PDc)
Sample size (n) = 4

Q	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0.0	50.00	49.76	49.33	49.00	48.67	48.33	48.00	47.67	47.33	47.00
0.1	46.67	46.33	46.00	45.67	45.33	45.00	44.67	44.33	44.00	43.67
0.2	43.33	43.00	42.67	42.33	42.00	41.67	41.33	41.00	40.76	40.33
0.3	40.00	39.67	39.33	39.00	38.67	38.33	38.00	37.67	37.33	37.00
0.4	36.67	36.33	36.00	35.67	35.33	35.00	34.67	34.33	34.00	33.67
0.5	33.33	33.00	32.67	32.33	32.00	31.67	31.33	31.00	30.67	30.33
0.6	30.00	29.67	29.33	29.00	28.67	28.33	28.00	27.67	27.33	27.00
0.7	26.67	26.33	26.00	25.67	25.33	25.00	24.67	24.33	24.00	23.67
0.8	23.33	23.00	22.67	22.33	22.00	21.67	21.33	21.00	20.67	20.33
0.9	20.00	19.67	19.33	19.00	18.67	18.33	18.00	17.67	17.33	17.00
1.0	16.67	16.33	16.00	15.67	15.33	15.00	14.67	14.33	14.00	13.67
1.1	13.33	13.00	12.67	12.33	12.00	11.67	11.33	11.00	10.67	10.33
1.2	10.00	9.67	9.33	9.00	8.67	8.33	8.00	7.67	7.33	7.00
1.3	6.67	6.33	6.00	5.67	5.33	5.00	4.67	4.33	4.00	3.67
1.4	3.33	3.00	2.67	2.33	2.00	1.67	1.33	1.00	0.67	0.33
1.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

For values of Q greater than or equal to zero, the estimate of percent defective (PDc) is read directly from the table. For values of Q less than zero, the table value must be subtracted from 100. Values of Q greater than what is on the table indicate that there is 0.00 % unacceptable material.

TABLE 8 (CONT.): Estimated percent defective for-compressive strength (PDc)
Sample size (n) = 5

Q	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0.0	50.0	49.64	49.29	48.93	48.58	48.22	47.86	47.51	47.15	46.80
0.1	46.44	46.09	45.73	45.38	45.02	44.76	44.31	43.96	43.60	43.25
0.2	42.90	42.54	42.19	41.84	41.48	41.13	40.78	40.43	40.08	39.72
0.3	39.37	39.02	38.67	38.32	37.97	37.62	37.28	36.93	36.58	36.23
0.4	35.88	35.54	35.19	34.85	34.50	34.16	33.81	33.47	33.12	32.78
0.5	32.44	32.10	31.76	31.42	31.08	30.74	30.40	30.06	29.73	29.39
0.6	29.05	28.72	28.39	28.05	27.72	27.39	27.06	26.73	26.40	26.07
0.7	25.74	25.41	25.09	24.76	24.44	24.11	23.79	23.47	23.15	22.83
0.8	22.51	22.19	21.87	21.56	21.24	20.93	20.62	20.31	20.00	19.69
0.9	19.38	19.07	18.77	18.46	18.16	17.86	17.55	17.25	16.96	16.66
1.0	16.36	16.07	15.78	15.48	15.19	14.91	14.62	14.33	14.05	13.76
1.1	13.48	13.20	12.93	12.65	12.37	12.10	11.83	11.56	11.29	11.02
1.2	10.76	10.50	10.23	9.97	9.72	9.46	9.21	8.96	8.71	8.46
1.3	8.21	7.97	7.73	7.49	7.25	7.02	6.79	6.56	6.33	6.10
1.4	5.88	5.66	5.44	5.23	5.02	4.81	4.60	4.39	4.19	3.99
1.5	3.80	3.61	3.42	3.23	3.05	2.87	2.69	2.52	2.35	2.19
1.6	2.03	1.87	1.72	1.57	1.42	1.28	1.15	1.02	0.89	0.77
1.7	0.66	0.55	0.45	0.36	0.27	0.19	0.12	0.06	0.02	0.00

For values of Q greater than or equal to zero, the estimate of percent defective (PDc) is read directly from the table. For values of Q less than zero, the table value must be subtracted from 100. Values of Q greater than what is on the table indicate that there is 0.00 % unacceptable material.

TABLE 8 (CONT.): Estimated percent defective for compressive strength (PDc)
Sample size (n) = 6

Q	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0.0	50.00	49.63	49.27	48.90	48.53	48.16	47.80	47.43	47.06	46.70
0.1	46.33	45.96	45.60	45.23	44.86	44.50	44.13	43.77	43.40	43.04
0.2	42.68	42.31	41.95	41.59	41.22	40.86	40.50	40.14	39.78	39.42
0.3	39.06	38.70	38.34	37.98	37.62	37.27	36.91	36.55	36.20	35.84
0.4	35.49	35.14	34.79	34.43	34.08	33.73	33.38	33.04	32.69	32.34
0.5	32.00	31.65	31.31	30.96	30.62	30.28	29.94	29.60	29.26	28.93
0.6	28.59	28.25	27.92	27.59	27.26	26.92	26.60	26.27	25.94	25.61
0.7	25.29	24.96	24.64	24.32	24.00	23.68	23.37	23.05	22.74	22.42
0.8	22.11	21.80	21.49	21.18	20.88	20.57	20.27	19.97	19.67	19.37
0.9	19.07	18.78	18.49	18.19	17.90	17.61	17.33	17.04	16.76	16.48
1.0	16.20	15.92	15.64	15.37	15.09	14.82	14.55	14.29	14.02	13.76
1.1	13.50	13.24	12.98	12.72	12.47	12.22	11.97	11.72	11.47	11.23
1.2	10.99	10.75	10.51	10.28	10.04	9.81	9.58	9.36	9.13	8.91
1.3	8.69	8.48	8.26	8.05	7.84	7.63	7.42	7.22	7.02	6.82
1.4	6.63	6.43	6.24	6.05	5.87	5.68	5.50	5.33	5.15	4.98
1.5	4.81	4.64	4.47	4.31	4.15	4.00	3.84	3.69	3.54	3.40
1.6	3.25	3.11	2.97	2.84	2.71	2.58	2.45	2.33	2.21	2.09
1.7	1.98	1.87	1.76	1.66	1.55	1.45	1.36	1.27	1.18	1.09
1.8	1.01	0.93	0.85	0.78	0.71	0.64	0.57	0.51	0.46	0.40
1.9	0.35	0.30	0.26	0.22	0.18	0.15	0.12	0.09	0.07	0.05
2.0	0.03	0.02	0.01	.0.00	0.00	0.00	0.00	0.00	0.00	0.00

For values of Q greater than or equal to zero, the estimate of percent defective (PDc) is read directly from the table. For values of Q less than zero, the table value must be subtracted from 100. Values of Q greater than what is on the table indicate that there is 0.00 % unacceptable material.

TABLE 8 (CONT.): Estimated percent defective for compressive strength (PDc)
Sample size (n) = 7

Q	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0.0	50.00	49.63	49.25	48.88	48.50	48.13	47.75	47.38	47.01	46.63
0.1	46.26	45.89	45.51	45.14	44.77	44.40	44.03	43.65	43.28	42.91
0.2	42.54	42.17	41.80	41.44	41.07	40.70	40.33	39.97	39.60	39.23
0.3	38.87	38.50	38.14	37.78	37.42	37.05	36.69	36.33	35.98	35.62
0.4	35.26	34.90	34.55	34.19	33.84	33.49	33.13	32.78	32.43	32.08
0.5	31.74	31.39	31.04	30.70	30.36	30.01	29.67	29.33	28.99	28.66
0.6	28.32	27.98	27.65	27.32	26.99	26.66	26.33	26.00	25.68	25.35
0.7	25.03	24.71	24.39	24.07	23.75	23.44	23.12	22.81	22.50	22.19
0.8	21.88	21.58	21.27	20.97	20.67	20.37	20.07	19.78	19.48	19.19
0.9	18.90	18.61	18.33	18.04	17.76	17.48	17.20	16.92	16.65	16.37
1.0	16.10	15.83	15.56	15.30	15.03	14.77	14.51	14.26	14.00	13.75
1.1	13.49	13.25	13.00	12.75	12.51	12.27	12.03	11.79	11.56	11.33
1.2	11.10	10.87	10.65	10.42	10.20	9.98	9.77	9.55	9.34	9.13
1.3	8.93	8.72	8.52	8.32	8.12	7.92	7.73	7.54	7.35	7.17
1.4	6.98	6.80	6.62	6.45	6.27	6.10	5.93	5.77	5.60	5.44
1.5	5.28	5.13	4.97	4.82	4.67	4.52	4.38	4.24	4.10	3.96
1.6	3.83	3.69	3.57	3.44	3.31	3.19	3.07	2.95	2.84	2.73
1.7	2.62	2.51	2.41	2.30	2.20	2.11	2.01	1.92	1.83	1.74
1.8	1.65	1.57	1.49	1.41	1.34	1.26	1.19	1.12	1.06	0.99
1.9	0.93	0.87	0.81	0.76	0.70	0.65	0.60	0.56	0.51	0.47
2.0	0.43	0.39	0.36	0.32	0.29	0.26	0.23	0.21	0.18	0.16
2.1	0.14	0.12	0.10	0.08	0.07	0.06	0.05	0.04	0.03	0.02
2.2	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00

For values of Q greater than or equal to zero, the estimate of percent defective (PDc) is read directly from the table. For values of Q less than zero, the table value must be subtracted from 100. Values of Q greater than what is on the table indicate that there is 0.00 % unacceptable material.

TABLE 8 (CONT.): Estimated percent defective for compressive strength (PDc)
Sample size (n) =8

Q	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0.0	50.00	49.62	49.24	48.86	48.49	48.11	47.73	47.35	46.97	46.59
0.1	46.22	45.84	45.46	45.08	44.71	44.33	43.96	43.58	43.21	42.83
0.2	42.46	42.08	41.71	41.34	40.97	40.59	40.22	39.85	39.48	39.11
0.3	38.75	38.38	38.01	37.65	37.28	36.92	36.55	36.19	35.83	35.47
0.4	35.11	34.75	34.39	34.04	33.68	33.33	32.97	32.62	32.27	31.92
0.5	31.57	31.22	30.87	30.53	30.18	29.84	29.50	29.16	28.82	28.48
0.6	28.15	27.81	27.48	27.15	26.82	26.49	26.16	25.83	25.51	25.19
0.7	24.86	24.54	24.23	23.91	23.59	23.28	22.97	22.66	22.35	22.04
0.8	21.74	21.44	21.14	20.84	20.54	20.24	19.95	19.66	19.37	19.08
0.9	18.79	18.51	18.23	17.95	17.67	17.39	17.12	16.85	16.57	16.31
1.0	16.04	15.78	15.51	15.25	15.00	14.74	14.49	14.24	13.99	13.74
1.1	13.49	13.25	13.01	12.77	12.54	12.30	12.07	11.84	11.61	11.39
1.2	11.17	10.94	10.73	10.51	10.30	10.09	9.88	9.67	9.47	9.26
1.3	9.06	8.87	8.67	8.48	8.29	8.10	7.91	7.73	7.55	7.37
1.4	7.19	7.02	6.85	6.68	6.51	6.35	6.19	6.03	5.87	5.71
1.5	5.56	5.41	5.26	5.12	4.97	4.83	4.69	4.56	4.42	4.29
1.6	4.16	4.03	3.91	3.79	3.67	3.55	3.43	3.32	3.21	3.10
1.7	2.99	2.89	2.79	2.69	2.59	2.49	2.40	2.31	2.22	2.13
1.8	2.04	1.96	1.88	1.80	1.72	1.65	1.58	1.51	1.44	1.37
1.9	1.31	1.24	1.18	1.12	1.07	1.01	0.96	0.91	0.86	0.81
2.0	0.76	0.72	0.67	0.63	0.59	0.55	0.52	0.48	0.45	0.42
2.1	0.39	0.36	0.33	0.30	0.28	0.26	0.23	0.21	0.19	0.17
2.2	0.16	0.14	0.13	0.11	0.10	0.09	0.08	0.07	0.06	0.05
2.3	0.04	0.04	0.03	0.02	0.02	0.02	0.01	0.01	0.01	0.00

For values of Q greater than or equal to zero, the estimate of percent defective (PDc) is read directly from the table. For values of Q less than zero, the table value must be subtracted from 100. Values of Q greater than what is on the table indicate that there is 0.00 % unacceptable material.

TABLE 8 (CONT.): Estimated percent defective for compressive strength (PDc)
Sample size (n) =9

Q	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0.0	50.00	49.62	49.24	48.85	48.47	48.09	47.71	47.33	46.95	46.57
0.1	46.18	45.80	45.42	45.04	44.66	44.29	43.91	43.53	43.15	42.77
0.2	42.40	42.02	41.64	41.27	40.89	40.52	40.15	39.77	39.40	39.03
0.3	38.66	38.29	37.92	37.55	37.19	36.82	36.46	36.09	35.73	35.37
0.4	35.00	34.64	34.29	33.93	33.57	33.21	32.86	32.51	32.15	31.80
0.5	31.45	31.10	30.76	30.41	30.07	29.72	29.38	29.04	28.70	28.36
0.6	28.03	27.69	27.36	27.03	26.70	26.37	26.04	25.72	25.39	25.07
0.7	24.75	24.43	24.11	23.80	23.49	23.17	22.86	22.56	22.25	21.94
0.8	21.64	21.34	21.04	20.75	20.45	20.16	19.87	19.58	19.29	19.00
0.9	18.72	18.44	18.16	17.88	17.61	17.33	17.06	16.79	16.53	16.26
1.0	16.00	15.74	15.48	15.23	14.97	14.72	14.47	14.22	13.98	13.73
1.1	13.49	13.26	13.02	12.79	12.55	12.32	12.10	11.87	11.65	11.43
1.2	11.21	10.99	10.78	10.57	10.36	10.15	9.95	9.75	9.55	9.35
1.3	9.16	8.96	8.77	8.59	8.40	8.22	8.04	7.86	7.68	7.51
1.4	7.33	7.17	7.00	6.83	6.67	6.51	6.35	6.20	6.04	5.89
1.5	5.74	5.60	5.45	5.31	5.17	5.03	4.90	4.77	4.64	4.51
1.6	4.38	4.26	4.14	4.02	3.90	3.78	3.67	3.56	3.45	3.34
1.7	3.24	3.14	3.03	2.94	2.84	2.75	2.65	2.56	2.47	2.39
1.8	2.30	2.22	2.14	2.06	1.98	1.91	1.84	1.76	1.70	1.63
1.9	1.56	1.50	1.44	1.37	1.32	1.26	1.20	1.15	1.10	1.05
2.0	1.00	0.95	0.90	0.86	0.82	0.77	0.73	0.70	0.66	0.62
2.1	0.59	0.55	0.52	0.49	0.46	0.43	0.41	0.38	0.36	0.33
2.2	0.31	0.29	0.27	0.25	0.23	0.21	0.20	0.18	0.17	0.15
2.3	0.14	0.13	0.11	0.10	0.09	0.08	0.08	0.07	0.06	0.05
2.4	0.05	0.04	0.04	0.03	0.03	0.02	0.02	0.02	0.01	0.01
2.5	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00

For values of Q greater than or equal to zero, the estimate of percent defective (PDc) is read directly from the table. For values of Q less than zero, the table value must be subtracted from 100. Values of Q greater than what is on the table indicate that there is 0.00 % unacceptable material.

TABLE 8 (CONT.): Estimated percent defective for compressive strength (PDc)
Sample size (n) =10

Q	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0.0	50.0	49.62	49.23	48.85	48.46	48.08	47.70	47.31	46.93	46.54
0.1	46.16	45.78	45.40	45.01	44.63	44.25	43.87	43.49	43.11	42.73
0.2	42.35	41.97	41.60	41.22	40.84	40.47	40.09	39.72	39.34	38.97
0.3	38.60	38.23	37.86	37.49	37.12	36.75	36.38	36.02	35.65	35.29
0.4	34.93	34.57	34.21	33.85	33.49	33.13	32.78	32.42	32.07	31.72
0.5	31.37	31.02	30.67	30.32	29.98	29.64	29.29	28.95	28.61	28.28
0.6	27.94	27.60	27.27	26.94	26.61	26.28	25.96	25.63	25.31	24.99
0.7	24.67	24.35	24.03	23.72	23.41	23.10	22.79	22.48	22.18	21.87
0.8	21.57	21.27	20.98	20.68	20.39	20.10	19.81	19.52	19.23	18.95
0.9	18.67	18.39	18.11	17.84	17.56	17.29	17.03	16.76	16.49	16.23
1.0	15.97	15.72	15.46	15.21	14.96	14.71	14.46	14.22	13.97	13.73
1.1	13.50	13.26	13.03	12.80	12.57	12.34	12.12	11.90	11.68	11.46
1.2	11.24	11.03	10.82	10.61	10.41	10.21	10.00	9.81	9.61	9.42
1.3	9.22	9.03	8.85	8.66	8.48	8.30	8.12	7.95	7.77	7.60
1.4	7.44	7.27	7.10	6.94	6.78	6.63	6.47	6.32	6.17	6.02
1.5	5.87	5.73	5.59	5.45	5.31	5.18	5.05	4.92	4.79	4.66
1.6	4.54	4.41	4.30	4.18	4.06	3.95	3.84	3.73	3.62	3.52
1.7	3.41	3.31	3.21	3.11	3.02	2.93	2.83	2.74	2.66	2.57
1.8	2.49	2.40	2.32	2.25	2.17	2.09	2.02	1.95	1.88	1.81
1.9	1.75	1.68	1.62	1.56	1.50	1.44	1.38	1.33	1.27	1.22
2.0	1.17	1.12	1.07	1.03	0.98	0.94	0.90	0.86	0.82	0.78
2.1	0.74	0.71	0.67	0.64	0.61	0.58	0.55	0.52	0.49	0.46
2.2	0.44	0.41	0.39	0.37	0.34	0.32	0.30	0.29	0.27	0.25
2.3	0.23	0.22	0.20	0.19	0.18	0.16	0.15	0.14	0.13	0.12
2.4	0.11	0.10	0.09	0.08	0.08	0.07	0.06	0.06	0.05	0.05
2.5	0.04	0.04	0.03	0.03	0.03	0.02	0.02	0.02	0.01	0.01
2.6	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00

For values of Q greater than or equal to zero, the estimate of percent defective (PDc) is read directly from the table. For values of Q less than zero, the table value must be subtracted from 100. Values of Q greater than what is on the table indicate that there is 0.00 % unacceptable material.

TABLE 8 (CONT.): Estimated percent defective for compressive strength (PDc)
Sample size (n) >10

Q	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0.0	50.00	49.60	49.20	48.80	48.40	48.01	47.61	47.21	46.81	46.41
0.1	46.02	45..62	45.22	44.83	44.43	44.04	43.64	43.25	42.86	42.47
0.2	42.07	41.68	41.29	40.90	40.52	40.13	39.74	39.36	38.97	38.59
0.3	38.21	37.83	37.45	37.07	36.69	36.32	35.94	35.57	35.20	34.83
0.4	34.46	34.09	33.72	33.36	33.00	32.64	32.28	31.92	31.56	31.21
0.5	30.85	30.50	30.15	29.81	29.46	29.12	28.77	28.43	28.10	27.76
0.6	27.43	27.09	26.76	26.43	26.11	25.78	25.46	25.14	24.38	24.51
0.7	24.20	23.89	23.58	23.27	22.95	22.66	22.36	22.06	21.77	21.48
0.8	21.19	20.90	20.61	20.33	20.05	19.77	19.49	19.22	18.94	18.67
0.9	18.41	18.14	17.88	17.62	17.36	17.11	16.85	16.60	16.35	16.11
1.0	15.87	15.62	15.39	15.15	14.92	14.69	14.46	14.23	14.01	13.79
1.1	13.57	13.35	13.14	12.92	12.71	12.51	12.30	12.10	11.90	11.70
1.2	11.51	11.31	11.12	10.93	10.75	10.56	10.38	10.20	10.03	9.85
1.3	9.68	9.51	9.34	9.80	9.01	8.85	8.69	8.53	8.38	8.23
1.4	8.08	7.93	7.78	7.64	7.49	7.35	7.21	7.08	6.94	6.81
1.5	6.68	6.55	6.43	6.30	6.18	6.06	5.94	5.82	5.71	5.59
1.6	5.48	5.37	5.26	5.16	5.05	4.95	4.85	4.75	4.65	4.55
1.7	4.46	4.36	4.27	4.18	4.09	4.01	3.92	3.84	3.75	3.67
1.8	3.59	3.51	3.44	3.36	3.29	3.22	3.14	3.07	3.01	2.94
1.9	2.87	2.81	2.74	2.68	2.62	2.56	2.50	2.44	2.39	2.33
2.0	2.28	2.22	2.17	2.12	2.07	2.02	1.97	1.92	1.88	1.83
2.1	1.79	1.74	1.70	1.66	1.62	1.58	1.54	1.50	1.46	1.43
2.2	1.39	1.36	1.32	1.29	1.25	1.22	1.19	1.16	1.13	1.10
2.3	1.07	1.04	1.02	0.99	0.96	0.94	0.91	0.89	0.87	0.84
2.4	0.82	0.80	0.78	0.75	0.73	0.71	0.69	0.68	0.68	0.64
2.5	0.62	0.60	0.59	0.57	0.55	0.54	0.52	0.51	0.49	0.48
2.6	0.47	0.45	0.44	0.43	0.41	0.40	0.39	0.38	0.37	0.36
2.7	0.35	0.34	0.33	0.32	0.31	0.30	0.29	0.28	0.27	0.26
2.8	0.26	0.25	0.24	0.23	0.23	0.22	0.21	0.21	.20	.19
2.9	.19	.18	.18	.17	.16	.16	.15	.15	.14	.14
3.0	.13	.13	.13	.12	.12	.11	.11	.11	.10	.10

For values of Q greater than or equal to zero, the estimate of percent defective (PDc) is read directly from the table. For values of Q less than zero, the table value must be subtracted from 100. Values of Q greater than what is on the table indicate that there is 0.00 % unacceptable material.

TABLE 9

QC/QA ACCEPTANCE TEST RESULTS

SHEET		OF												
PROJECT NO		BRIDGE NO		REF NO		QUANTITY		CLASS		JMF #		PLACEMENT DATE		
CONTRACTOR		PRODUCER / LOCATION		CERTIFIED LABORATORY / LOCATION										

QC or QA	LOAD	LOCATION	SPECIMEN NO	SUB LOT SIZE	BATCH TICKET NO	BATCH SIZE	BATCH WT	UNIT WT	YIELD	AGGREGATE MOISTURE FINE	AGGREGATE MOISTURE COARSE
	STRENGTH 1		STRENGTH 2		STRENGTH AVG		AIR		SLUMP		

QC or QA	LOAD	LOCATION	SPECIMEN NO	SUB LOT SIZE	BATCH TICKET NO	BATCH SIZE	BATCH WT	UNIT WT	YIELD	AGGREGATE MOISTURE FINE	AGGREGATE MOISTURE COARSE
	STRENGTH 1		STRENGTH 2		STRENGTH AVG		AIR		SLUMP		

QC or QA	LOAD	LOCATION	SPECIMEN NO	SUB LOT SIZE	BATCH TICKET NO	BATCH SIZE	BATCH WT	UNIT WT	YIELD	AGGREGATE MOISTURE FINE	AGGREGATE MOISTURE COARSE
	STRENGTH 1		STRENGTH 2		STRENGTH AVG		AIR		SLUMP		

QC or QA	LOAD	LOCATION	SPECIMEN NO	SUB LOT SIZE	BATCH TICKET NO	BATCH SIZE	BATCH WT	UNIT WT	YIELD	AGGREGATE MOISTURE FINE	AGGREGATE MOISTURE COARSE
	STRENGTH 1		STRENGTH 2		STRENGTH AVG		AIR		SLUMP		

QC or QA	LOAD	LOCATION	SPECIMEN NO	SUB LOT SIZE	BATCH TICKET NO	BATCH SIZE	BATCH WT	UNIT WT	YIELD	AGGREGATE MOISTURE FINE	AGGREGATE MOISTURE COARSE
	STRENGTH 1		STRENGTH 2		STRENGTH AVG		AIR		SLUMP		

QC or QA	LOAD	LOCATION	SPECIMEN NO	SUB LOT SIZE	BATCH TICKET NO	BATCH SIZE	BATCH WT	UNIT WT	YIELD	AGGREGATE MOISTURE FINE	AGGREGATE MOISTURE COARSE
	STRENGTH 1		STRENGTH 2		STRENGTH AVG		AIR		SLUMP		

QC or QA	LOAD	LOCATION	SPECIMEN NO	SUB LOT SIZE	BATCH TICKET NO	BATCH SIZE	BATCH WT	UNIT WT	YIELD	AGGREGATE MOISTURE FINE	AGGREGATE MOISTURE COARSE
	STRENGTH 1		STRENGTH 2		STRENGTH AVG		AIR		SLUMP		

QC or QA	LOAD	LOCATION	SPECIMEN NO	SUB LOT SIZE	BATCH TICKET NO	BATCH SIZE	BATCH WT	UNIT WT	YIELD	AGGREGATE MOISTURE FINE	AGGREGATE MOISTURE COARSE
	STRENGTH 1		STRENGTH 2		STRENGTH AVG		AIR		SLUMP		

Signature from Certified laboratory	Date	Signature from Contractor	Date

TABLE 10	QC/QA PLASTIC AIR AND SLUMP RESULTS	SHEET		OF	

PLACEMENT DATE		CLASS OF CONCRETE		MINIMUM AIR		MAXIMUM AIR	
				See SS898 – TABLE 2		Established for mix	

NAMES OF TECHNICIANS PERFORMING QC TESTS					

METHOD OF REDUCING AIR LOSS IF PUMPED	

LOAD	SLUMP	AIR @ DISCHARGE	AIR @ PLACMENT	LOAD	SLUMP	AIR @ DISCHARGE	AIR @ PLACMENT

Signature from Certified laboratory	Date	Signature from Contractor	Date