MICHIGAN
DEPARTMENT OF TRANSPORTATION

SPECIAL PROVISION
FOR
QUALITY CONTROL AND ACCEPTANCE OF PORTLAND CEMENT CONCRETE

C&T:JFS 1 of 27 C&T:APPR:JAB:EMB:07-27-11
FHWA:APPR:08-05-11

a. Description. The Contractor must administer quality control (QC) and the Department will administer quality assurance (QA) procedures that will be used for acceptance of and payment for all Portland cement concrete (PCC) for the project. Except as explicitly modified by this special provision, all materials, test methods, and PCC mixture requirements of the standard specifications and the contract apply.

Provide the Engineer a minimum 24 hours notification prior to each concrete placement.

1. Terminology.

Acceptable Quality Level (AQL). The threshold levels for the quality index parameters that would warrant 100 percent payment for the concrete lot.

Air Content of Fresh Concrete. The recorded total air content of fresh concrete sampled and tested according to this special provision.

Air Content Test Results. The recorded total air content of fresh concrete that is used to mold corresponding strength test specimens for acceptance.

Concrete Mix Design. The process, by which the concrete mixture performance characteristics are defined, based on selected materials, performance requirements, environmental exposure considerations, placement methods, and other factors that control the plastic and hardened properties of the concrete in efforts to produce an economical and durable product.

Critical Concrete Acceptance Items. Concrete pay items that are eligible for positive (quality initiative) or negative price adjustments based on the overall lot pay factor (OLPF) for the measured quality index parameters. All quality index parameters must be within their respective AQLs in order for the lot to be eligible for positive price adjustment (quality initiative). The following Contract Items (Pay Items) are Critical Concrete Acceptance Items and may be eligible for positive price adjustment (quality initiative) only if they are analyzed for price adjustment using percent within limits (PWL).

A. Substructure Conc.

B. Superstructure Conc. (including high performance).

C. Superstructure Conc, Night Casting.

D. Conc Pavt (including high performance) (excluding temporary).

E. Conc Pavt, Misc. (including high performance).

F. Conc Pavt with Integral Curb.

G. Conc Pavt, Ovly, Furnishing and Placing (including. high performance).

H. Conc Pavt, Ovly, Misc., Furnishing and Placing (including high performance)

I. Shoulder (including high performance)

J. Freeway Shoulder (Portland cement concrete option only).

Dispute Resolution. The process used to referee discrepancies between the Contractor's QC test results and the Department's QA test results. Dispute resolution pertains only to concrete lots subject to quality index analysis for PWL applications.

Job Mix Formula (JMF). The actual batch quantities (mixture proportions) of each constituent included in the concrete mixture, based on adjustments to the target weights from the mix design, necessary to optimize the concrete mixture properties. Submit mix design and JMF on the MDOT Job Mix Formula (JMF) Concrete Field Communication form; include accompanying documentation.

Lot. A discrete cubic yard quantity of concrete containing the same JMF and used for the same application, typically made up of five sublots, as described in subsection d.2.A.

Non-Critical Concrete Acceptance Items. Concrete pay items that are not eligible for positive price adjustment (quality initiative), but are subject to negative price adjustments based on the measured quality index parameter(s). Concrete intended for early opening to traffic will not be eligible for positive price adjustment (quality initiative).

Non-PWL Applications. Project specific applications where the total quantity of concrete is insufficient to generate the minimum number of test results for quality index analysis as described in subsection d.3. Positive price adjustment (quality initiative) does not apply for non-PWL applications. Pay factor determination and price adjustment will be according to non-PWL applications described in subsection d.5.

Overall Lot Pay Factor (OLPF). The factor that is determined according to the formula included in subsection d.4 for PWL applications, based on the combined quality index parameters used to determine the price adjustment for a lot of the material, described in subsection d.4.

Pay Factor (PF). The factor that is determined according to formulas herein, used to calculate the price adjustment for a discrete quantity of concrete relative to its respective level of quality. Pay factor determination using PWL, which is intended to be used for continuous or semi-continuous concrete placement applications of approximately 250 cubic yards or more, will be according to PWL applications described in subsection d.4. Pay factor determination for small or intermittent concrete placement applications will be in accordance with the requirements in subsection d.5.

Percent Within Limits (PWL). The cumulative area under a standard bell-shaped curve which represents the estimated percentage of a lot that falls above the Lower Specification Limit (LSL), below the Upper Specification Limit (USL), or between the LSL and USL. The

PWL will be determined using this special provision and the MDOT Concrete PWL Worksheet.

Quality Assurance (QA). Activities administered by the Department dealing with acceptance of the product, including, but not limited to, materials sampling, testing, construction inspection, and review of Contractor QC documentation. All concrete QA sampling and testing will be performed by the Engineer. Department administered QA is described in section d of this special provision.

Quality Control (QC). All activities administered by the Contractor to monitor, assess, and adjust production and placement processes to ensure the final product will meet the specified levels of quality, including, but not limited to, training, materials sampling, testing, project oversight and documentation. Contractor administered QC is described in section c of this special provision.

QC Action Limits. A range of values established by the Contractor in the QC plan that, if exceeded, requires that corrective action be taken by the Contractor to restore the continuity and uniformity of the mixture and methods in conformance with specification requirements. The QC action limits must not exceed the QC suspension limits.

QC Plan. The project-specific plan developed by the Contractor describing, in detail, all aspects of production and construction for the project to ensure consistent control of quality to meet specification requirements.

QC Plan Administrator. An employee of, or consultant engaged by the Contractor, responsible for developing and overseeing all aspects of QC for the project. This includes, but is not limited to preparing the QC plan, managing the Contractor QC personnel, communicating routinely with the production personnel to ensure quality, initiating corrective action and suspending operations when the process is found to be producing non-conforming materials, and preparing and submitting all necessary QC documentation to the Engineer within the specified time period. The QC Plan Administrator must be a certified concrete technician (Michigan Level II), or have direct authority over a certified concrete technician (Michigan Level II) for the project.

QC Suspension Limits. A range of values defined in Table 2 that, if exceeded on a single QC test, requires that the Contractor suspend operations and determine, correct, and document the deficiencies before resuming production. The Engineer must approve all changes prior to resuming production. The QC suspension limit must not exceed specification requirement thresholds.

Quality Index. The percent of material that meets specification.

Quality Index Parameter. The quality characteristics that are evaluated under the Department's QA program and on which payment for material is based. The quality index parameters used for PWL application price adjustment are 28-day compressive strength (LSL) and air content of fresh concrete. The quality index parameter used for non-PWL application price adjustment is 28-day compressive strength (LSL).

Quality Initiative. A budgeted amount established to cover the potential positive price adjustment for critical concrete acceptance items. Items not listed in subsection a.1, for Critical Concrete Acceptance Items, including any items associated with concrete repairs,

regardless of the application or total quantity of concrete, are not eligible for positive price adjustment (quality initiative) consideration. Non-PWL applications described in subsection d.5 are not eligible for positive price adjustment (quality initiative) consideration.

Rejectable Quality Level (RQL). The threshold limits for the quality index parameters that if not met, would require rejection of the concrete lot.

Sampling Rate. The number of times the fresh concrete is sampled per lot, or batched quantity, where applicable. For PWL applications, the sampling rate will be one sample per sublot, based on random numbers. For small production quantities, the sampling rate will be determined by the Engineer during concrete placement, as described in subsection d.2.B.

Small Incidental Quantity. A single day's placement of less than 20 cubic yards of concrete used for non-structural or non-pavement related applications, including, but not limited to: curb and gutter, sidewalks and sidewalk ramps (excluding driveways and driveway ramps), installing sign or fence posts, guard rail or cable rail foundations (excluding end anchorage foundations), or other contract items where the small quantity of concrete is not paid for separately, as directed by the Engineer. Price adjustment will not be applied to small incidental quantities provided all other provisions are met for the respective contract item. Requirements for small incidental quantity consideration are described in subsections c.5.G, d.2.A, and d.2.B. The corresponding weekly QA 28-day compressive strength test results must meet specification limits defined in Table 4.

Small Production Quantity. A quantity of concrete having the same JMF that is anticipated to be less than 250 cubic yards, or any quantity of concrete having the same JMF for the project that will be intermittently placed throughout the project in a manner that will prohibit consistent or timely completion of a lot. Small production quantity concrete placements for the project will be determined by the Engineer at the pre-production meeting. Representative QA sampling and testing for small production quantities will be determined by the Engineer during concrete placement. The QA sampling rate will be based on site conditions at the time of concrete placement. Quality index analysis using PWL will not apply and the pay factor determination and price adjustment for each small production quantity will be according to non-PWL applications described in subsection d.5.

Specification Limits. The threshold values placed on a quality characteristic used to evaluate the quality of the material.

Strength Sample Test Result. A strength sample test result consists of the 28-day compressive strength of the 6-inch by 12-inch or 4-inch by 8-inch cylindrical strength test specimens. For PWL applications, each individual strength test specimen sampled from each production sublot is considered a strength sample test result. For non-PWL applications, a strength sample test result is the average of the two companion strength test specimens sampled from the concrete.

Strength Test Specimen. A strength test specimen is defined as each individual 6-inch by 12-inch strength test cylinder or 4-inch by 8-inch strength test cylinder molded and cured according to AASHTO T 23 and tested according to AASHTO T 22. All respective QC or QA strength test specimens must be the same nominal size.

Note: Strength test specimen cylinder size of 4-inch by 8-inch is permitted only if the nominal maximum coarse aggregate particle size, as specified for the coarse aggregate in the concrete mixture, is 1-inch or less (not permitted for Grade P1M concrete).

Sublot. A portion of a lot represented by a complete set of QA tests, as described in subsection d.2.A. The Engineer and the Contractor may agree to reduce the typical sublot size based on project staging or other project conditions.

b. Materials. Mixture requirements must be in accordance with the contract.

c. Contractor Administered Quality Control (QC).

1. Contractor Quality Control Plan (QC Plan). Prepare, implement, and maintain a QC plan specific to the project for concrete that will provide quality oversight for production, testing, and control of construction processes. The QC plan must identify all procedures used to control production and placement including when to initiate corrective action necessary to maintain the quality and uniformity of the work.

Develop concrete mix designs and JMFs, as specified, and conduct QC sampling, testing, and inspection during all phases of the concrete work at the minimum frequency, or at an increased frequency sufficient to ensure that the work conforms to specification requirements.

Project-specific items and quality characteristics required in the QC plan include, but are not limited to the following:

A. Organization chart.

B. QC Plan Administrator and contact information.

C. The name(s) and credentials of the QC staff.

D. Methods for interaction between production and QC personnel to engage timely corrective action, including suspension of work.

E. Coordination of activities.

F. Documentation, procedures, and submittals.

G. Project and plant specifics.

H. Concrete production facilities inspections and certifications.

I. Current testing equipment calibration documentation including calibration factor.

J. Testing and initial field curing facilities for QC and QA specimens.

K. Stockpile management plan.

L. Corrective action plan.

M. Mixing time and transportation, including time from batching to completion of delivery and batch placement rate (batches per hour), along with the manufacturer's documentation relative to the batching equipment's capabilities in terms of maximum mixing capacity and minimum mixing time.

N. Placement and consolidation methods including monitoring of vibration, depth checks, and verification of pavement dowel bar alignment.

O. Process for monitoring stability of air content of fresh concrete during concrete production and placement.

P. Hot and cold weather protection considerations and methods.

Q. Control charts with action and suspension limits.

R. Verification for non-deleterious alkali-silica reactivity (see subsection c.5.A).

S. Mix design and JMFs.

T. Proposed lot size and location for use of each JMF on the project.

U. The frequency of sampling and testing.

V. Handling and protection of test specimens.

W. Methods to monitor construction equipment loading and open-to-traffic strengths.

X. Finishing and curing procedure.

Y. Ride quality control.

Submit the QC plan, for the appropriate items of work, to the Engineer for review a minimum of 10 working days before the start of related work. Do not begin concrete placement before acceptance of the QC plan by the Engineer. The Engineer will notify the Contractor of any objections relative to the content of the QC plan within 5 working days of receipt of the QC plan.

2. QC Records. Maintain complete records of all QC tests and inspections. Document what action was taken to correct deficiencies. Include sufficient information to allow the test results to be correlated with the items of work represented.

Furnish one copy of all QC records and test reports to the Engineer within 24 hours after the date covered by the record in a format acceptable to the Engineer. The Engineer will withhold acceptance of the concrete, and the Contractor will forfeit eligibility for dispute resolution consideration described in subsections d.6 through d.8, for failure to provide properly documented and timely QC records and reports.

If the Engineer is performing QA sampling and testing at the same time the Contractor is performing QC sampling and testing, all associated QC records must include the appropriate lot identification number that correlates with the Department's QA lot identification number.

3. Personnel Requirements. The QC Plan Administrator must have full authority and responsibility to take all actions necessary for the successful implementation of the QC plan, including but not limited to, the following:

A. Monitoring and utilizing QC tests, control charts, and other QC practices to ensure that delivered materials and proportioning meets specification requirements.

B. Monitoring materials shipped to the project, prior to their use, to ensure their continued compatibility toward producing consistent quality.

C. Periodically inspecting all equipment utilized in transporting, proportioning, mixing, placing, consolidating, finishing, and curing to ensure proper operation.

D. Monitoring materials stockpile management, concrete batching, mixing, transporting, placement, consolidation, finishing, and curing to ensure conformance with specification requirements.

E. Maintaining and submitting all QC records and reports.

F. Directing the necessary corrective action to ensure continual conformance within the QC action limits.

G. Suspending production for the project when suspension limits are exceeded.

H. Conducting or monitoring adjustments to the JMF.

Individuals performing QC tests must demonstrate that they are proficient and capable of sampling and testing concrete or aggregate, where applicable, in accordance with the associated test procedures and Department requirements prior to commencement of related work. Any adjustments to the JMF must be made by a certified concrete technician (Michigan Level II).

QC tests may be considered eligible to initiate consideration for dispute resolution only if the respective QC sampling and testing was conducted by qualified personnel possessing the current applicable certification through Michigan Concrete Association (Michigan Level I or II) or through the Michigan Concrete Paving Association (Level I or II) certified concrete technicians, or (MCAT) certified aggregate technician, where applicable, in the same, but not concurrent, random manner as the QA sampling and testing for the associated lot of materials.

4. QC Laboratory Requirements. Laboratories, including field laboratories and all associated testing equipment that prepare concrete mixes or perform QC testing, must demonstrate to the Engineer that they are equipped, staffed, calibrated, and managed so as to be capable of batching, and testing Portland cement concrete in accordance with the applicable test methods and procedures. Mix designs and their accompanying JMFs must include a statement, signed by a certified concrete technician (Michigan Level II), that all applicable standard test methods have been followed in verifying the mix design and JMF.

5. Mix Design and Documentation. Design concrete mixtures meeting the requirements specified in Table 1. Provide the grade of concrete for the section number reference

application specified in Table 1 or as specified in the contract. Request variance in writing when proposing a mix design that exhibits temperature, slump or air content other than those specified. Include the proposed mix design, JMF, and associated trial batch verification test data. Do not use a grade of concrete with an AQL 28-day compressive strength greater than what is designated for the application. Unless specified otherwise, concrete mixtures using optimized aggregate gradation may be used in lieu of standard concrete mixtures for other applications, as approved by the Engineer.

Secure prior approval from the Engineer to use concrete intended for early opening to traffic to facilitate driveway gaps or other features necessary for required local access.

Table 1: Minimum Mix Design Requirements for Concrete

Mix Design Parameter	Grade of Concrete					
	D/DM (a, f)	S1	T	S2/P1	P1M (f)	S3/P2
Lower Specification Limit (LSL) (28 day compressive, psi) (b)	5000	4500	4000	4000	4000	3500
Rejection Limit for an Individual Sample or Sublot – Lower	4000	3500	3000	3000	3000	2500
Maximum Water/Cementitious Ratio (lb/lb)	0.45					
Cementitious Material Content (lb/yd^3) (e)	517-658 (d)	517-611 (c)	517-611 (c)	517-611 (c, d)	470-564 (c, d)	500-564 (c, d)
Air Content (percent)	(g)					
Slump (inch) (max.)	(h)					
Section Number Reference (i)	706, 711, 712	705	705, 706	401, 602, 603, 705, 706, 712, 713, 801, 802, 803, 810	602, 603	402, 403, 803, 804, 806, 808, 810, 813, 814, 819

a. Water reducing admixture is required.
b. Or 90 percent of Lower Specification Limit at 7 days.
c. Cementitious material may be reduced by 5 percent if a water reducing or water reducing and retarding admixture is used.
d. If the local average minimum temperature for the next 10 consecutive days is forecast to be below 40 degrees F, submit a revised QC plan, for the Engineer's approval, addressing, in detail, changes in materials, concrete batching and mixing processes, construction methods, curing, and protection of the in situ concrete to ensure that the necessary quality characteristics of the hardened concrete product will not be compromised as a result of the cold weather. The revised QC plan must be approved by the Engineer prior to cold weather concrete placement.
e. Type III cement is not permitted.
f. Grade P1M and Grade DM concrete requires an optimized aggregate gradation (See MTM 130 for Optimized Aggregate Gradation). Use aggregates from only geologically natural sources. Coarse aggregates must meet the physical requirements specified in subsection 902.03.C. Provide concrete mixture (Grade P1M) for high performance mainline pavements, shoulders, miscellaneous pavements (including ramps) and concrete overlay applications. Provide concrete mixture (Grade DM) for high performance bridge superstructure applications.
g. Air content of fresh concrete. Limits for full pay consideration are 5.5 – 8.0 percent, see Tables 3 and 4, where applicable. Air content of fresh concrete less than 5.5 percent for concrete that lies in the finished work at least 3 feet below the surface of the ground or entirely under water will not be cause for rejection
h. The maximum slump for Grades P1, P1M, and P2 concrete is 3 inches or as documented on the approved JMF. All other grades of concrete will be according to Tables 701-1 A and B of the Standard Specifications for Construction.

i. Section Number Reference:

401 Culverts	402 Storm Sewers
403 Drainage Structures	602 Concrete Pavement
603 Concrete Pavement Restoration	705 Foundation Piling
706 Structural Concrete Construction	711 Bridge Railings
712 Bridge Rehabilitation-Concrete	713 Bridge Rehabilitation-Steel
801 Concrete Driveways	802 Concrete Curb, Gutter and Dividers
803 Concrete Sidewalk, Sidewalk Ramps, and Steps	804 Concrete Barriers and Glare Screens
806 Bicycle Paths	808 Fencing
810 Permanent Traffic Signs and Supports	813 Slope Protection
814 Paved Ditches	819 Electrical and Lighting

Provide concrete mixture (Grade P1M) for high performance mainline pavements, shoulders, miscellaneous pavements (including ramps) and concrete overlay applications. Provide concrete mixture (Grade DM) for high performance bridge superstructure applications. The Engineer may approve Grades P1M and DM for other applications. Use the MTM 130 for Optimized Aggregate Gradation to develop and monitor the optimized gradation.

Unless specified otherwise, do not exceed 40 percent substitution by volume of the total cementitious materials. Use the combined weight of all cementitious materials to determine compliance with the maximum water-cementitious ratio and cementitious material content requirements specified in Table 1. Include provisions for cold and hot weather protection in the QC plan.

Use admixture dosage as indicated in the Qualified Products List to reduce mixing water. For night casting, where applicable, a water-reducing admixture may be used in lieu of a water-reducing and retarding admixture, provided the concrete can be placed and finished in the sequence specified on the plans prior to initial set, is not subjected to residual vibration, or is not within the areas influenced by dead load deflections as a result of adjacent concrete placement operations.

A. Alkali-Silica Reactivity. Provide documentation to the Engineer that the concrete mixture does not present the potential for excessive expansion caused by alkali-silica reactivity (ASR). Testing may be from other Department projects or from records provided by the aggregate suppliers. Provide the latest test results (valid for 2 years) conforming to the specified criterion for one of the following standard test methods for the material to be used in the project.

- ASTM C 1260. Mortar Bar Test. If the expansion of the mortar bars is less than 0.10 percent at 14 days of immersion, the aggregate is considered non-deleterious to ASR reactivity and may be used in the concrete.

- ASTM C 1293. Concrete Prism Test. If the expansion of concrete prisms is not greater than 0.040 percent after 1 year, the aggregate is considered non-deleterious to ASR reactivity and may be used in the concrete.

If the concrete mixture exceeds the limits in the ASTM used, then the Engineer will not approve the use of that concrete mixture.

If no previous test data are available for the concrete mixture that shows it is resistant to ASR, mitigate the potential for ASR using either Method 1 or 2, as follows:

(1) Method 1. Replace 25 to 40 percent of the Portland cement in the concrete mixture with Class F fly ash or Slag Cement (Grade 100 minimum). A blended cement meeting the requirements of ASTM C 595 containing Portland cement and slag cement or Class F fly ash may also be used.

Demonstrate the ability of the fly ash or slag cement to control the deleterious expansion caused by ASR by molding and testing mortar bars according to the standard test method described in ASTM C 1567 using the mix proportions for both the aggregates and the cementitious materials proposed for the project. Make at least three test specimens for each cementitious materials-aggregate combination. If the average of three mortar bars for a given cementitious materials-aggregate combination produces an expansion is less than 0.10 percent at 14 days of immersion, the JMF associated with that combination will be considered non-deleterious to ASR reactivity. If the average expansion is 0.10 percent or greater, the JMF associated with that combination will be considered not sufficient to control the deleterious expansion caused by ASR and the JMF will be rejected.

(2) Method 2. Use Low-Alkali cement with equivalent alkalies (Na_2O + 0.658 × percent K_2O) not exceeding 0.60 percent. The total alkali content for the cementitious materials combination must not exceed 3.0 pounds per cubic yard (Na_2O equivalent).

B. Contractor Provided Mixes. Provide mix design and accompanying JMFs using the methods of verification included in this special provision. Include sufficient information on constituent materials and admixtures along with aggregate gradation analysis, trial batch verified physical properties of the fresh concrete, mix proportions per cubic yard for all constituents and compressive strength test results necessary to allow the Engineer to fully evaluate the expected performance of the concrete mixture.

(1) Mix Documentation. Prepare mix designs for each grade of concrete required on the project. Submit JMF for each mix design, including all required documentation, to the Engineer for review 10 working days before the anticipated date of placement. The Engineer will notify the Contractor of any objections within 5 working days of receipt of the mix documentation. Number or otherwise identify each JMF and reference all accompanying documentation to this number. Reference each JMF to the appropriate method of verification. Mix design and JMF submittals that do not include all required documentation will be considered incomplete and the Engineer will return them without review.

Provide all supporting mix documentation, including test reports and mix proportion adjustment calculations. All mix designs and accompanying JMFs must be traceable to a laboratory meeting the requirements of this special provision. Include the necessary documentation described in subsection c.5.

Submit mix design and JMF on the MDOT Job Mix Formula (JMF) Concrete Field Communication form; include accompanying documentation. List the source of materials, bulk density (unit weight) of coarse aggregate (rodding procedure or shoveling procedure), absorption of aggregates, relative density (specific gravity) of aggregates, aggregate correction factors, batch weights, and project specific or historical laboratory test data. Include the recorded air content of fresh concrete

using the same admixture and cementitious material sources to be used in the production of the concrete for the project. The 28-day compressive strength and air content of fresh concrete for the concrete which is reported as part of the mix documentation submittal must meet the specification limits described in Table 3.

Re-evaluation of 28-day compressive strength is not required when making adjustments to the aggregate mix proportions included in the JMF for mixtures including optimized aggregate gradation (See MTM 130 for Optimized Aggregate Gradation).

(2) Job Mix Formula (JMF). Select proportions for concrete mixtures according to ACI Standard 211.1. The volume of coarse aggregate per unit volume of concrete must be 65 to 75 percent, inclusive. For concrete mixtures using optimized aggregate gradation, the above specified volume of coarse aggregate per unit volume of concrete includes the intermediate aggregate.

Four methods of verification of proposed JMF are acceptable.

(a) Method 1. Trial Batches. Base trial batches on the same materials and proportions proposed for use on the project. Prepare at least one trial batch for each mix design in sufficient time before starting concrete placement to allow for review according to subsection c.5.B.(1). Provide the results of temperature, slump, density (unit weight), air content of fresh concrete, 28-day compressive strength, and age of concrete at the time of strength testing, for a minimum of three independent samples. For JMF trial batch verification purposes only, compressive strength test results at 7-days which report at least 70 percent of the specified lower specification limit (LSL) at 28-day will be sufficient documentation in lieu of 28-day compressive strengths. The average of at least two strength test specimens represents one compressive strength sample test result. A JMF will be considered approved for use only if all of the physical properties of the concrete (as described above) are within specification limits. Provide the necessary ASR documentation as described in subsection c.5.A.

(b) Method 2. Same Mix. Verification based on experience with the same mix design, JMF, and the same materials. Provide the results of temperature, slump, density (unit weight) air content of fresh concrete, 28-day compressive strength, and age of concrete at the time of strength testing, for a minimum of three independent samples. The average of at least two strength test specimens represents one compressive strength sample test result. Do not substitute material types or sources, including admixtures or cementitious materials, nor change mix proportions in the JMF. A JMF will be considered approved for use only if all of the physical properties of the concrete (as described above) are within specification limits. Provide the necessary ASR documentation as described in subsection c.5.A.

(c) Method 3. Similar Mix. Verification based on experience with a mix design and JMF similar to the proposed mix design that used similar coarse aggregate materials. Substitution of coarse and intermediate aggregate sources is permitted only if the new source is of the same geologic type and meets minimum physical properties as the original aggregate and conforms to the specification requirements for the respective application. Verify, prior to

batching, that the proposed changes to the JMF will not affect the properties of the fresh concrete (slump, temperature, air content, density (unit weight), workability), nor result in excessive mortar bar expansion as a result of deleterious reactivity between the aggregates and cementitious materials as described in subsection c.5.A.

Provide the supporting laboratory test documentation as for Method 1. Include all material properties for the original and substituted aggregates. Submit calculations showing how the mix proportions in the JMF were adjusted, based on the documented differences in relative density (specific gravity), bulk density (unit weight) and absorption of the substituted aggregate sources, to produce a theoretical yield of 100 percent.

(d) Method 4. Annual Verification. At the Engineer's option, verification may be accepted annually for a concrete plant rather than on a project basis provided the sources and proportions of the constituent materials, including cementitious materials and source and types admixtures, do not change. If the project is the continuation of work in progress during the previous construction season and written certification is submitted to the Engineer that materials from the same source and with the same mixture properties are to be used, the Engineer may waive the requirement for annual renewal verification of the JMF for the project. . Provide the necessary ASR documentation as described in subsection c.5.A.

C. Department Provided Mixes. For projects that include a total project quantity of less than 100 cubic yards of a single grade of concrete, the Contractor may request the Engineer to provide the concrete JMF based on the Contractor's choice of materials from approved sources. These JMFs are specific to the respective section number referenced applications included in Table 1. Utilization of a Department provided JMF does not relieve the Contractor of obligations for QC and acceptance according to this special provision and the contract, where applicable.

Unless otherwise specified in the contract, the Engineer will provide the concrete JMF for the following types of concrete regardless of the total quantity for the project.

- Structural concrete repair mixtures, and concrete patching mixtures, mortar and grout.
- Prestressed concrete.
- Bridge deck overlay concrete mixtures.
- Project-specific concrete grades not defined in Table 1.

Modifications to a Department provided concrete mixture are restricted to adjustment required for yield verification and decreased water content. All costs associated with Contractor modifications to a Department provided JMF and verification of compatibility of mixture constituents will be borne by the Contractor including verification for non-deleterious alkali-silica reactivity described in subsection c.5.A.

The Engineer will not provide the JMF for concrete mixtures including optimized aggregate gradations. Refer to subsection c.5.B for mix design and documentation

requirements for concrete mixtures using optimized aggregate gradations, regardless of the total quantity for the project.

D. Changes in Materials and Proportions. Any changing from one approved JMF to another for the same grade of concrete must have prior approval by the Engineer. Record all changes to JMF in the QC records along with the rationale for the change. Verify, prior to batching, that the proposed changes to the JMF will not affect the properties of the fresh concrete (slump, temperature, air content, density (unit weight), workability), nor result in excessive mortar bar expansion as a result of deleterious reactivity between the aggregates and cementitious materials as described in subsection c.5.A.

E. QC Sampling and Testing. Conduct startup sampling and testing for temperature, slump, density (unit weight), and air content on the first load. Do not place concrete until testing verifies that the fresh concrete properties have not exceeded the QC action and suspension limit thresholds specified in Table 2. Continue testing subsequent loads as described in the QC plan, for each grade of concrete delivered to the work site each day. Startup or initial sampling and testing will not be eligible for consideration to initiate dispute resolution process. The QC sampling and testing must be random and independent from the Department's QA sampling and testing.

The Department's established procedures for sampling and testing are acceptable alternatives. The following ASTM test methods will apply.

C 31 Making and Curing Concrete Test Specimens in the Field
C 39 Compressive Strength of Cylindrical Concrete Specimens
C 78 Flexural Strength of Concrete (Using Simple Beam with Third-Point Loading)
C 138 Unit Weight, Yield and Air Content (Gravimetric) of Concrete
C 143 Slump of Hydraulic Cement Concrete
C 172 Sampling Freshly Mixed Concrete
C 173 Air Content of Freshly Mixed Concrete by the Volumetric Method
C 231 Air Content of Freshly Mixed Concrete by the Pressure Method
C 293 Flexural Strength of Concrete (Using Simple Beam with Center-Point Loading)

Perform QC sampling and testing of the fresh concrete for air content loss at least once during each week of concrete production, or whenever QC tests have shown that QC action limits have been exceeded, whichever is more frequent. Sample and test a representative haul unit of concrete immediately after its discharge but before the paver or pump hopper, where applicable. Sample and test the concrete representing the same haul unit, again, after the paver or after discharge from the pump, where applicable. If the difference in measured air content between the two test locations for the same concrete is greater than two percent air by volume of concrete, suspend operations and administer corrective action. Resume concrete placement only after taking the necessary corrective action to reduce the loss in air content of fresh concrete between the two test locations, as approved by the Engineer. Document the corrective action to be taken in the QC records and make the necessary changes to the QC plan, where applicable.

The Contractor's QC and the Department's QA strength test specimens for 28-day compressive strength must be the same size (either 6-inch by 12-inch or 4-inch by 8-inch) for lot dispute resolution consideration.

Concrete exceeding the maximum specification limits for slump must be rejected regardless of the total mixing time or number of mixing revolutions at the time of arrival to the project.

The Engineer may require the Contractor to administer additional QC sampling and testing if the Engineer determines the Contractor's current QC sampling and testing methodology is shown to be insufficient to ensure continual control of the quality of the concrete.

Take the appropriate corrective action, as described in the QC plan, when QC testing shows the QC action limits for any quality characteristic are exceeded. Suspend production if any of the QC suspension limits are exceeded or if the corrective action is not sufficient to restore the quality to acceptable levels.

Resume production only after making all necessary adjustments to bring the mixture into conformance with all applicable specifications and receiving approval to resume work from the Engineer. Document these adjustments in the QC records.

Table 2: Action and Suspension Limits

Quality Characteristic	Action Limits	Suspension Limits
Air Content (percent)	As Defined in the Contractor QC Plan	< 5.0 or > 8.5
Air Content Loss (percent)		Greater than 2.0
Conc. Temp. (Deg. F)		< 45 or > 90 at time of placement
Slump (max.) (inch)		See Table 1, footnote (h)
Density (unit weight)		N/A
Aggregate Gradation	MTM 130 for Optimized Aggregate Gradation (for optimized aggregate gradation only)	

F. Work Progress Test Specimens. Determine the strength of concrete for opening to construction traffic or regular traffic, for removing shoring and forms, or for other similar purposes in accordance with subsections 104.11 and 701.03.D of the Standard Specifications for Construction, and as approved by the Engineer. Cure work progress test specimens in the same manner as the in-situ concrete. Allow the Engineer to witness testing of work progress cylinder or beam specimens and non-destructive testing, including calibration tests.

For pavement repairs described in section 603 of the Standard Specifications for Construction, the maturity method may be used to determine the in-place, opening-to-traffic flexural strength, provided the necessary preliminary flexural strength versus opening-to-traffic time correlations, using the same materials and JMF, are established and approved by the Engineer before placing the concrete.

G. Reduced QC for Small Incidental Quantities. Reduced levels of on-site QC testing for concrete may be considered for small incidental quantities defined in

subsection a.1 provided provisions for administering reduced QC testing and oversight are included in the approved QC plan and the following criteria are met.

(1) The small incidental quantity of concrete will be limited to a single day's concrete placement.

(2) The small incidental quantity is not an integral part of a structural load bearing element.

(3) The small incidental quantity is not an integral part of a critical concrete acceptance item.

(4) The Engineer received written certification from the Contractor that the concrete supplier has a current QC plan in place and available for review upon request by the Engineer.

(5) The concrete supplier employs a certified concrete technician (Michigan Level II) available at the plant or on call during concrete placement to validate and authorize modifications to the concrete JMF, as necessary.

(6) Prior to the first concreting operation, concrete representing the JMF for the small incidental quantity has been sampled and tested by a certified concrete technician (Michigan Level I or II) to verify that, historically, the JMF produced a concrete mixture meeting the minimum requirements for density (unit weight), slump, air content, and strength. Annual verification may be acceptable provided there are no changes to the material types or sources, including cementitious materials and admixtures.

(7) The Engineer verified that the temperature, slump, and air content conform to specification requirements at the start of the day's concreting operation associated with the small incidental quantity.

(8) The Engineer is notified and provided sufficient opportunity to witness concrete placement.

d. Department Administered Quality Assurance (Acceptance).

1. Department Quality Assurance Plan (QA plan). The Engineer will be responsible for administering the quality-based acceptance and will institute any actions necessary toward its successful implementation.

The Engineer will develop and follow a QA plan. The Engineer will provide the QA plan to the QC Plan Administrator a minimum of 7 calendar days prior to the pre-production meeting. The QA plan will be reviewed at the pre-production meeting and any proposed changes will be documented.

The nominal QA strength test specimen size, defined in subsection a.1 will be noted in the QA plan.

A. Personnel Requirements. The personnel responsible for field inspection and for obtaining QA samples will possess the required qualifications to collect QA samples.

Sampling will be performed by qualified personnel possessing the current applicable certification through the Michigan Concrete Association (Michigan Level I or II) or through the Michigan Concrete Paving Association (Level I or II) certified concrete technicians, or (MCAT) certified aggregate technician, where applicable.

B. QA Testing Correlation. The testing equipment and associated testing personnel for both the Engineer's QA and Contractor's QC will conduct side by side testing of the same concrete representing the first production lot for the project to verify correlation of both the Department's and the Contractor's test results for slump, temperature, and air content of fresh concrete. The temperature measuring devices used for QC and QA must correlate relative to each other within 2 degrees F. The Engineer will request an Independent Assurance Test in the event the air content results of two tests conducted between the Department's and the Contractor's testers differ by more than 0.8 percent air by volume of concrete.

C. Laboratory Facilities. The testing laboratory with responsibility for acceptance testing on this project is the Region testing laboratory, or a qualified facility under the authority of the Engineer. Dispute resolution testing for 28-day compressive strength will be conducted at the Department's Central C&T laboratory or an independent AASHTO Accredited laboratory facility designated by the Department.

2. QA Sampling and Testing. The Engineer will conduct QA sampling and testing, monitor the Contractor's adherence to the QC plan, and inspect field placed materials. Initial approval is required prior to concrete placement for, temperature, slump, air content and aggregate gradation (if utilizing an optimized aggregate gradation), and is based on the Engineer's observance of QC startup sampling and testing described in subsection c.5.E. Final acceptance for payment is based on quality index analysis of randomly sampled fresh concrete..

A. Lot Size and Make Up. A lot will not include more than one grade of concrete, concrete of the same grade having different specified slump or air content, or concrete of the same grade having different mix designs or JMFs. Concrete for non-PWL applications will not be included in the production lot and will be sampled in such a manner so as to assure that all non-PWL concrete for the project is equally represented by random samples.

Consecutively placed concrete mixes where the aggregate proportions were adjusted to maintain an optimized gradation may be included in the same lot provided they are the same grade and same JMF.

Use the stratified random sampling procedures described in section A-12 of the *Materials Quality Assurance Procedures Manual* to determine the random location for collecting QA samples. . The anticipated sublot/sampling frequency for a lot of concrete material is five sublots per lot with one sampling per sublot, as follows:

- Applications where the quantity of concrete included in the lot is anticipated to be 250 cubic yards, or greater, each lot will consist of either a single day's production or an accumulation of semi-continuous sublots sufficient to produce timely completion of the lot.

- Applications where the quantity of concrete is anticipated to be less than 250 cubic yards, the Engineer may establish small production quantities, as defined in subsection a.1. The sampling rate for small production quantity concrete placements will be determined by the Engineer at the pre-production meeting.

- At the option of the Engineer, small production quantities, as defined in subsection a.1, may be established for a JMF, regardless of the total quantity of concrete for the project, if the project-specific staging for concrete placement prohibits consistent or timely completion of a lot. The sampling rate for small production quantity concrete placements will be determined by the Engineer at the pre-production meeting.

- At the option of the Engineer, daily 28-day compressive strength QA test cylinders for small incidental quantities of concrete, as defined in subsection a.1, may not be required provided QA test cylinders representing the same JMF as the small incidental quantity of concrete were sampled and molded at least once during the same week (see subsection d.2.B).

If a sublot is not completed in sufficient quantity to permit it to be randomly sampled during its respective production day, as planned, the quantity of concrete for the sublot that was not placed as part of the day's production will be sampled during the following production day according to the original random number sampling protocol. The random sample will then represent the total quantity of concrete for the sublot placed over the respective multiple days of production.

If the quantity of a grade of concrete to be sampled on the last day of production for the project is not sufficient to make up three or more equivalent sublots, combine the test results for these one or two remaining sublots, or fraction thereof, with the previous day's production lot for quality index analysis.

At the option of the Engineer, occasional small individual quantities of concrete up to 100 cubic yards may be combined with a larger production lot provided they are of the same grade, contain the same JMF, and are used for the same application.

B. Random Sampling. Except as modified herein, QA sample locations will be determined as described in section A-12 of the *Materials Quality Assurance Procedures Manual*. Random sampling will be based on cumulative volumes of concrete in cubic yards for the respective production lot. For PWL applications, random sampling will be as follows:

(1) Prior to the pre-production meeting, the Engineer will generate a list of random numbers using a computer spreadsheet program or a calculator. The random numbers will be used to designate when QA samples are to be taken, based on cubic yard quantities.

(2) At the pre-production meeting, each page that lists random numbers will be signed by the QC Plan Administrator and the Engineer. Each sheet containing the random numbers will be covered by a separate sheet of paper so as prevent disclosure of the random numbers.

(3) The original signed list will be placed in the project file and a copy will be provided to the Engineer's field inspector for the project.

(4) When the project is completed, a copy of the list of random numbers will be provided to the Contractor upon request.

For small production quantities, representative QA sampling and testing will be determined by the Engineer during concrete placement. The sampling rate will not exceed one sample per 50 cubic yards, or as directed by the Engineer, based on site conditions at the time of concrete placement.

At the option of the Engineer, small incidental quantities as defined in subsection a.1 may be accepted (visually inspected and noted on the Inspector's Daily Report) without daily 28-day compressive strength QA test specimens provided there is a current acceptable strength test history of the JMF for the project prior to placement of the small incidental quantity. One set of compressive strength QA test specimens will then be molded for each small incidental quantity JMF at least once per week during production, thereafter, as directed by the Engineer (note the test results or identification number for the corresponding weekly QA compressive strength test result on the Inspector's Daily Report for each small incidental quantity). Quality control testing and daily QA testing for temperature, slump, and air content are still required as described in subsection c.5.G.

C. Sampling and Testing. Samples will be taken from the concrete at the location as close to its final placement into the forms or on the grade as practical.

Samples for acceptance will not be taken at the concrete production facility (batch plant), nor prior to discharge from a concrete pump (excluding tremie seal placement applications). Mix adjustments to the concrete contained within the haul unit selected for QA sampling and testing will not be permitted prior to QA sampling and testing.

The location(s) within the project limits for QA testing of the fresh concrete and placement of curing facilities for initial curing of the 28-day compressive strength QA test cylinders will be determined by the Engineer in conformance with the following criteria:

(1) The elapsed time between obtaining the first and the final portion of the composite sample must not exceed 15 minutes.

(2) Testing for slump, temperature, and air content of fresh concrete must begin within 5 minutes after obtaining the final portion of the composite sample.

(3) Molding of the 28-day compressive strength QA test cylinders must begin within 15 minutes after obtaining the final portion of the composite sample.

(4) The concrete sample must be protected from the sun, wind, and other sources of rapid evaporation, and from contamination.

Two QA concrete strength test specimens per sample will be molded for 28-day compressive strength QA testing. For PWL applications only, two additional concrete strength test specimens will be molded and cured in the same manner as the QA specimens, to be retained by the Department in the event of dispute resolution.

The Contractor will provide curing facilities equipped to ensure the proper environment for the Department's QA concrete strength test specimens during initial cure. Each initial cure facility must provide ventilation or insulation, where applicable, to ensure the ambient temperature surrounding the specimens is maintained to prevent extreme exposure. Failure by the Contractor to maintain the proper curing environment during initial cure will not be basis for rejection of samples, dispute resolution, or claim against the Department. Each initial curing facility must be capable of being locked, using a Department provided padlock. The Contractor will ensure that all initial curing facilities are accounted for at all time, and protected against, theft and damage. The Contractor will locate and secure each initial cure facility throughout the project limits in such a manner so as to minimize excessive transport of the test specimens prior to initial cure, as follows:

- Immediately after finishing molded specimens, the Engineer will move the QA concrete strength test specimens to the closest initial cure facility provided by the Contractor.

- Immediately after all QA concrete strength test specimens are placed into the cure facility and the Contractor has established the proper initial curing conditions, the Engineer will secure the facility using the Department provided padlock. Access to the QA concrete strength test specimens, thereafter, must be coordinated with the Engineer and will only be permitted in the presence of the Engineer.

- The Engineer will transport the QA concrete strength test specimens within 48 hours after molding, but not prior to 8 hours after final set of the concrete, to the Department's designated testing laboratory for final curing and strength testing. The specimens will be protected with a suitable cushioning material to prevent damage from jarring during transport. The total transportation time must not exceed 4 hours prior to commencement of final curing.

The dispute resolution QA concrete strength test specimens will be tested by the Engineer only in the event of dispute resolution according to subsection d.6.

D. QA Stop Production Criteria. The Engineer will issue a Notice of Non-Compliance with Contract Requirements (Form 1165) and concrete production must stop when one or more of the following are observed.

(1) The QA testing shows that one or more of the suspension limits for quality characteristics defined in Table 2 are in non-compliance.

(2) The QC plan is not being followed.

(3) Segregation, excessive slumping of unsupported slipformed edges, or other notable changes in the fresh concrete properties is observed that may prevent proper placement, consolidation and finishing, or compromise the performance or long-term durability of the finished product.

(4) The required curing system is not being applied in a timely manner, as specified by the contract.

(5) If the difference in measured air content between the two testing locations for the same concrete is greater than two percent air by volume of concrete, as follows:

(a) immediately after discharge but before the paver or pump hopper (where applicable), and

(b) after the paver or discharge from the pump (where applicable).

The Engineer will issue a Notice to Resume Work (Form 1165) only after all necessary adjustments are made to restore conformance with all applicable specifications, and the appropriate documentation is made in the QC records.

E. QA Records. The Engineer will maintain a complete record of all QA tests and inspections. The records will contain, as a minimum, signed originals of all QA test results and raw data, random numbers used and resulting calculations. The QA test results will not be provided to the Contractor until the corresponding QC test results are received by the Engineer.

3. Quality Index Analysis. The Engineer's QA test results will be used to determine the pay factor (PF) and price adjustment (ADJ). The Contractor's QC test results will not be used for quality index analysis. The Engineer will complete quality index analysis and pay factor determination within 7 days after completion of all 28-day compressive strength testing for the representative lot or quantity of concrete.

For non-PWL applications, the PF and associated ADJ will be determined according to subsection d.5.

For PWL applications, the PF and associated ADJ will be determined according to subsection d.4 using the MDOT Concrete PWL Worksheet. The LSL and USL used in the quality index analysis are shown in Table 3. The Engineer will perform the quality index analysis for all concrete represented by sufficient lot size and makeup necessary for random sampling according to subsections d.2.A and d.2.B. All values of PWL and PF in these formulae are percent, not decimal. All values of PWL are carried to whole numbers and PF are carried to two decimal places as shown in the MDOT Concrete PWL Worksheet.

Table 3: Quality Index Parameter Specification Limits for PWL Applications

Quality Index Parameters	Grade of Concrete				
	D/DM	S1	S2/P1	P1M	S3/P2
Acceptable Quality Level (AQL)	90 Percent Within Limits (PWL)				
Rejectable Quality Level (RQL)	50 Percent Within Limits (PWL)				
28-Day Compressive Strength (psi)					
Specification Limit – Lower (LSL)	5000	4500	4000	4000	3500
Specification Limit – Upper (USL)	N/A				
Air Content of Fresh Concrete (percent)	LSL		USL		
Specification Limits	5.5		8.0		

A. Quality Index Analysis for Concrete Strength. Determine the quality index for 28-day compressive strength as follows.

(1) The LSL for 28-day compressive strength is defined in Table 3.

(2) Lots that are made up of only non-critical concrete acceptance items may be eligible for 100 percent payment for concrete strength PF if all 28-day compressive strength test results equal or exceed the concrete acceptance item's LSL. Whenever one or more strength test result falls below the LSL, the lot will be subject to ADJ or other provisions.

B. Quality Index Analysis for Air Content. Determine the quality index for air content of the fresh concrete as follows.

(1) The LSL and USL for air content of fresh concrete are defined in Table 3.

(2) Lots that are made up of only non-critical concrete acceptance items may be eligible for 100 percent payment for air content PF if all of the air content of fresh concrete test results are within the specification limits. Whenever one or more of the air content test results falls below the LSL or above the USL for air content of fresh concrete test results, the lot will be subject to ADJ or other provisions.

4. Pay Factor (PF) Determination and Price Adjustment for Percent Within Limits (PWL) Applications. The PF will be calculated for each lot, as follows. Round the value of PF two decimal places.

A. Pay Factor for 28-Day Compressive Strength (PF_s). If PWL for 28-day compressive strength (PWL_s) is between 100 and 70, use the following formula to determine PF_s.

$$PF_s = 55 + (0.5 \times PWL_s)$$

If PWL_s is between 70 and 50 inclusive, use the following formula to determine PF_s.

$$PF_s = 37.5 + (0.75 \times PWL_s)$$

If PWL_s is less than 50, the Engineer will elect to do one of the following.

(1) Require removal and replacement of the entire lot with new testing conducted on the replacement concrete and repeat the evaluation procedure.

(2) Allow the lot to remain in place and apply an OLPF of 50.00.

(3) Allow submittal of a corrective action plan for the Engineer's approval. If the Engineer does not approve the plan for corrective action, subsections (1) or (2) above will be applied. All costs associated with plan submittal and corrective action will be borne by the Contractor. Positive ADJ (quality initiative) will not apply for lots subject to corrective action.

B. Pay Factor for Air Content of Fresh Concrete (PF_{ac}). If PWL for air content of fresh concrete (PWL_{ac}) is between 100 and 70, use the following formula to determine PF_{ac}.

$$PF_{ac} = 55 + (0.5 \times PWL_{ac})$$

If PWL for air content of fresh concrete (PF_{ac}) is between 70 and 50 inclusive, use the following formula to determine PF_{ac}.

$$PF_{ac} = 37.5 + (0.75 \times PWL_{ac})$$

If PWL_{ac} is less than 50, the Engineer will elect to do one of the following.

(1) Require removal and replacement of the entire lot with new testing conducted on the replacement concrete and repeat the evaluation procedure.

(2) Allow the lot to remain in place and apply an OLPF of 50.00.

(3) Allow submittal of a corrective action plan for the Engineer's approval. If the Engineer does not approve the plan for corrective action, subsections (1) or (2) above will be applied. All costs associated with plan submittal and corrective action will be borne by the Contractor. Positive ADJ (quality initiative) will not apply for lots subject to corrective action.

C. Overall Lot Pay Factor (OLPF). Use the following formula to calculate the OLPF for the 28-day compressive strength and air content of fresh concrete. Both quality index parameters must meet their respective acceptable quality levels (AQL) shown in Table 3 for the lot to be eligible for positive ADJ (quality initiative) consideration.

$$OLPF = (0.60 \times PF_s) + (0.40 \times PF_{ac})$$

$$ADJ = (OLPF-100)(Quantity)(Price)/100$$

Where:

ADJ = Lot price adjustment for the contract item
Quantity = Quantity of item placed in the lot
Price = Contract unit price bid for the contract item

If a lot is comprised of more than one critical concrete acceptance item or is comprised of critical and non-critical concrete acceptance items, calculate the ADJ for each item in the lot separately as follows.

(1) Critical concrete acceptance items. Use the OLPF, the contract unit price for the item and the quantity of the item included in the lot.

(2) Non-critical concrete acceptance items. Use either the OLPF or 1.00, whichever is less, the contract unit price for the item, and the quantity of the non-critical concrete acceptance item included in the lot.

5. Pay Factor Determination and Price Adjustment for Non-PWL Applications. Use the following formulae to calculate the PF and associated ADJ for each concrete item not subject to PWL criteria. Positive ADJ (quality initiative) does not apply for non-PWL applications.

Table 4: Specification Limits for Non-PWL Applications

Quality Characteristic	Specification Limits
Air Content (percent)	5.5 – 8.0
Conc. Temp. (Deg. F)	45 - 90 at time of placement
Slump (max.) (inch)	See Table 1, footnote (h)
28-day Compressive Strength	LSL, See Table 1

The specification limits for the fresh concrete properties are defined in Table 4. Concrete not conforming to the requirements specified in Table 4 may be rejectable and subject to further evaluation, as directed by the Engineer.

The following types of concrete are not subject to PWL evaluation, as determined by the Engineer.

- Small production quantities.
- Small incidental quantities.
- Quantities of concrete that will be evaluated with less than three sublots.
- Structural repair and pavement repair concrete mixtures, and concrete patching mortar and grout.
- Prestressed concrete.
- Bridge deck overlay concrete mixtures.
- Concrete Grades P-NC, M, T, and X
- Project-specific concrete grades not defined in Table 1.

$$PF = \frac{\text{Tested Strength}}{\text{LSL}}$$

$$ADJ = (1\text{-}PF)\ (Quantity)(Price)$$

Where:

Tested Strength = QA 28-day compressive strength sample test result
LSL = Lower specification limit (see Table 1)
PF = Pay Factor (carried to two decimal places, not to exceed 1.00)
Quantity = Quantity of item represented by QA test
Price = Contract unit price bid for the contract item

6. Lot Dispute Resolution. Dispute resolution pertains only to concrete lots subject to quality index analysis for PWL applications. The 28-day compressive strength QA test results for a production lot of concrete may be eligible for dispute resolution only if the following criteria are met. The air content of fresh concrete is not eligible for dispute

resolution. The Contractor's 28-day compressive strength QC test results must be submitted to the Engineer prior to the Engineer's release of any QA test results for the respective production lot.

A. The request for dispute resolution testing was submitted by the Contractor in writing within 2 working days of receipt of the results of the quality index analysis for the lot.

B. The request for dispute resolution included the QC test results for the lot accompanied by a signed statement certifying that the QC test results are true and accurate.

C. Complete records and reports for all QC tests and inspections, including documentation of what action was taken to correct deficient concrete, along with sufficient information and lot identification to allow the test results to be correlated with the items of work represented, were submitted to the Engineer within 24 hours after the date covered by the records and reports.

D. The pay factor for 28-day compressive strength (PF_s), as re-calculated by the Engineer using the Contractor's QC test results, is greater than that determined by the Engineer using the QA test results.

E. QC sampling and testing was conducted in the same manner as the Department's QA sampling and testing.

F. The Contractor's QC and Department's QA 28-day compressive strength test specimen for the lot in dispute are the same nominal size (either 6-inch by 12-inch or 4-inch by 8-inch).

G. The QC sampling and testing for the production lot under dispute was conducted by qualified personnel possessing the current applicable certification through Michigan Concrete Association (Michigan Level I or II) or through the Michigan Concrete Paving Association (Level I or II) certified concrete technicians.

H. A current and complete QC plan, for the appropriate items of work, was submitted and approved by the Engineer prior to start of related work.

I. The QC sampling and testing was performed on the same lot of concrete as the Department's QA sampling and testing, and all associated QC records include the appropriate lot identification number that coincides with the Engineer's QA lot identification number.

J. The QC test results and documentation for aggregate gradation (where applicable), slump, air content of fresh concrete, temperature, and density (unit weight) of the fresh concrete were complete and within specification requirements.

K. The appropriate corrective action was taken in the event QC action limits were exceeded, as described in the QC plan.

L. QC suspension limits for the associated production lot of concrete were not exceeded.

Dispute resolution will not be considered if it is shown that the Contractor QC has not been completed in accordance with the approved QC plan.

If the Engineer determines, based on a review of original QA strength test results, QC test results, and other project records, that further evaluation is not warranted, the ADJ for the lot will be based on the Engineer's original 28-day compressive strength QA test results.

If the Engineer determines, based on the above criteria, that lot dispute resolution is warranted, the following schedule and testing process will be initiated.

7. Dispute Resolution Schedule.

A. The Engineer will document receipt of the request for dispute resolution and will deliver the dispute resolution samples along with the appropriate sample identification submittal forms to the MDOT C&T Central Laboratory for testing within 3 working day of the receipt of the request.

B. The Department's Central C&T laboratory will test all dispute resolution test specimens within 2 working days of their receipt.

C. The 28-day compressive strength (psi) LSL specified in Table 3 will be increased 10 psi for each additional day beyond 28-days after molding of the test specimens associated with the lot under dispute, up to and including 60 days after molding (32 additional days after 28-days; 320 psi to account for additional strength gain after the 28-day standard curing period).

D. The dispute resolution test results will be returned to the Engineer within 14 calendar days upon receiving the dispute resolution samples.

8. Dispute Resolution Testing Process.

A. All lot dispute resolution samples will be tested for the lot under dispute resolution.

B. All dispute resolution test results will replace respective original QA test results.

C. The adjusted LSL described in subsection d.7.C will then be used to determine the PWL for the production lot under dispute.

D. The PF_s for the lot under dispute will be recalculated using the compressive strength test results from the dispute resolution test specimens.

E. If the recalculated lot PF_s is less than or equal to the original corresponding PF_s, all costs associated with the dispute resolution sample testing will be borne by the Contractor.

F. If the recalculated lot PF_s is greater than the original corresponding PF_s, all costs associated with the dispute resolution sample testing will be borne by the Department.

G. The OLPF will then be recalculated using the PF_s from the compressive strength dispute resolution test results and the original corresponding PF_{ac}.

9. Re-evaluation of Rejectable Concrete. If the quality index analysis for concrete strength shows that the RQL has not been met for a lot, as specified in Table 3, or that the lower rejection limit for 28-day compressive strength has not been achieved for any sublot within a lot or, for non-PWL applications, any individual QA strength sample test result, as specified in Table 1, the associated concrete will be rejected and the Engineer will require additional evaluation to decide what further action may be warranted. If the Engineer determines that non-destructive testing (NDT) or coring is necessary, this work will be done by the Contractor in the presence of the Engineer within 45 days from concrete placement. All costs associated with this work will be borne by the Contractor. The Engineer will take custody of all cores intended for re-evaluation immediately after coring. If NDT is used to estimate the in-situ strength, a calibrated relationship between the concrete mixture and the NDT apparatus must have been established prior to NDT testing according to its respective standard test method. Test results from re-evaluation of rejectable concrete will not be used for PWL or PF evaluation or calculation purposes. However, if the results from re-evaluation confirm that the RQL has been exceeded for a lot, or that the lower rejection limit for 28-day compressive strength has not been achieved, as described above, the Engineer will elect to do one of the following.

A. Require removal and replacement of the entire lot or represented quantity of concrete with new initial tests and quality index analysis procedure conducted.

B. Allow the lot or represented quantity of concrete to remain in place and apply an adjustment of minus 50.00 percent to all concrete items in the lot.

C. For non-PWL applications, a plan for corrective action must be submitted, for the Engineer's approval, to address the disposition of the rejectable concrete. If the Engineer does not approve the plan for corrective action, subsection d.9.A or d.9.B will be applied.

e. Measurement and Payment. The completed work, as described, will be measured and paid for at the contract unit price using the following contract item (pay item):

Pay Item	**Pay Unit**
Conc Quality Initiative, Special	Dollar

Conc Quality Initiative, Special is a budgeted amount which is established to cover the potential positive ADJ for the contract items (pay items) defined in subsection a.1 for "Critical Concrete Acceptance Items".

Conc Quality Initiative, Special does not apply for non-PWL applications, small production quantities, and small incidental quantities, as described in this special provision, regardless of the contract item (pay item).

Price adjustment for each critical and non-critical concrete acceptance contract item is determined as described in this special provision.

If a contract unit price requires adjustment for other reasons not described in this special

provision, the contract unit price used to determine the lot ADJ described in this special provision will be based on an adjusted contract unit price.

Separate payment will not be made for providing, implementing, and maintaining an effective QC program. All costs associated with this work will be included in the applicable unit prices for the concrete items.

All costs associated with providing, locating, relocating, maintaining, and securing the adequate number of portable curing facilities for the project, necessary to provide sufficient initial curing for the Contractor's QC and Department's QA strength test specimens will be included in the applicable unit prices for the concrete items. No additional payment will be permitted. The Contractor is responsible for damage, theft, subsequent replacement, and removal after completion of the work for each curing facility used on the project. Failure to properly maintain and secure portable curing facilities and their content may result in rejection of the in-situ concrete represented by the QA strength test specimens.