This supplementary specification supplements, amends, and where in conflict therewith, supersedes Section 513, Structural Concrete of the 2003 Edition of the Wyoming Department of Transportation's Standard Specifications for Road and Bridge Construction.


DESCRIPTION: In accordance with Section 513.1, Description

MATERIALS: In accordance with Section 513.2, Materials

EQUIPMENT: In accordance with 513.3, Equipment

CONSTRUCTION: Add or modify the following subsections to Section 513.4, Construction:

513.4.4.1 Laboratory and Personnel Requirements

Ensure laboratories performing mix designs are accredited by the AASHTO Accreditation Program in accordance with subsection 114.2.1, Laboratory.

Provide field testing personnel in accordance with subsection 114.3, Field Testing Laboratory and Personnel Requirements. Ensure that certified technicians testing concrete hold a current certification in concrete from the Wyoming Materials Technician Certification Program.

For Levels of Control I, II, and III, provide a Quality Control Supervisor at the project during production of the portland cement concrete. Ensure that the Quality Control Supervisor holds a current certification in concrete from the Wyoming Materials Technician Certification Program.

Ensure test equipment to determine compressive strength is calibrated annually by an independent agency using calibration equipment traceable to the National Institute of Standards and Technology (NIST). Provide calibration documentation to the engineer.
513.4.4.2 Level of Control

The mix design requirements, the extent of Contractor Quality Control, and Department’s Quality Assurance are defined by the Level of Control. The required Level of Control is shown in Table I, Determining Level of Control. The Level of Control requirements are shown in Table II. Sampling frequency, including aggregate samples, is based on volume of concrete.

<table>
<thead>
<tr>
<th>Level of Control</th>
<th>Type of Placement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level I</td>
<td>Bridge Decks</td>
</tr>
<tr>
<td>Level II</td>
<td>Bridge substructure elements (pier caps, columns, footings, wingwalls, abutments), bridge deck curbs, approach slabs, drilled shafts, box culverts, building foundations, retaining walls, and cattleguard foundations.</td>
</tr>
<tr>
<td>Level III</td>
<td>All other concrete not listed in Levels I &amp; II, except erosion control concrete, concrete pavement, incidental concrete, and all applications of any class of concrete with total plan quantities less than 20 CY [15 m$^3$]. $(^1)$</td>
</tr>
<tr>
<td>Level IV</td>
<td>Concrete which is incidental to a non-concrete pay item and concrete of a specific class that has less than 20 CY [15 m$^3$] total plan quantity. $(^1)$</td>
</tr>
</tbody>
</table>

$(^1)$ Example: If the only Class B concrete on a project is 15 CY [12 m$^3$] of sidewalk, then it is Level IV. If the Class B concrete is 15 CY [12 m$^3$] of sidewalk and 15 CY [12 m$^3$] of curb and gutter, then the total plan quantity is 30 CY [24 m$^3$] and it would fall under Level III.
### TABLE II

**MINIMUM TESTING REQUIREMENTS**

<table>
<thead>
<tr>
<th></th>
<th>Level of Control I</th>
<th>Level of Control II and III</th>
<th>Level of Control IV</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>QUALITY CONTROL</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coarse Aggregate</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gradation</td>
<td>1/100 CY [75 m³]</td>
<td>1/200 CY [150 m³]</td>
<td>1 test</td>
</tr>
<tr>
<td>Moisture Content</td>
<td>1/day</td>
<td>1/day</td>
<td>1 test</td>
</tr>
<tr>
<td>Fine Aggregate</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gradation</td>
<td>1/100 CY [75 m³]</td>
<td>1/200 CY [150 m³]</td>
<td>1 test</td>
</tr>
<tr>
<td>Fineness Modulus</td>
<td>1/100 CY [75 m³]</td>
<td>1/200 CY [150 m³]</td>
<td>1 test</td>
</tr>
<tr>
<td>Moisture Content</td>
<td>1/day</td>
<td>1/day</td>
<td>1 test</td>
</tr>
<tr>
<td>Deleterious</td>
<td>1/200 CY [150 m³]</td>
<td>1/200 CY [150 m³]</td>
<td>1 test</td>
</tr>
<tr>
<td>Mix Production</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Compressive Str.</td>
<td>See footnote (1)</td>
<td>See footnote (1)</td>
<td>See footnote (1)</td>
</tr>
<tr>
<td>Air Content</td>
<td>1st load(3) then 1per 50 CY [35 m³]</td>
<td>1st load(3) then 1per 25 CY [20 m³]</td>
<td>1 test</td>
</tr>
<tr>
<td></td>
<td>then 1per 50 CY [35 m³]</td>
<td>then 1per 25 CY [20 m³]</td>
<td></td>
</tr>
<tr>
<td>Slump</td>
<td>1st load(3) then 1per 50 CY [35 m³]</td>
<td>1st load(3) then 1per 25 CY [20 m³]</td>
<td>1 test</td>
</tr>
<tr>
<td></td>
<td>then 1per 50 CY [35 m³]</td>
<td>then 1per 25 CY [20 m³]</td>
<td></td>
</tr>
<tr>
<td>Yield &amp; Unit Weight</td>
<td>1st load(3) then 1per 50 CY [35 m³]</td>
<td>1st load(3) then 1per 25 CY [20 m³]</td>
<td>1 test</td>
</tr>
<tr>
<td></td>
<td>then 1per 50 CY [35 m³]</td>
<td>then 1per 25 CY [20 m³]</td>
<td></td>
</tr>
<tr>
<td>Temperature</td>
<td>1st load(3) then 1per 50 CY [35 m³]</td>
<td>1st load(3) then 1per 25 CY [20 m³]</td>
<td>1 test</td>
</tr>
<tr>
<td></td>
<td>then 1per 50 CY [35 m³]</td>
<td>then 1per 25 CY [20 m³]</td>
<td></td>
</tr>
<tr>
<td><strong>QUALITY ACCEPTANCE</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Compressive Str. (28 Day)</td>
<td>1 set per subplot (4)</td>
<td>1 set per 100 CY <a href="4">75 m³</a></td>
<td>1 set (4)</td>
</tr>
<tr>
<td>Air Content(2)</td>
<td>1 test per subplot</td>
<td>1 test per 100 CY [75 m³]</td>
<td>1 test</td>
</tr>
<tr>
<td>Slump(2)</td>
<td>1 test per subplot</td>
<td>1 test per 100 CY [75 m³]</td>
<td>1 test</td>
</tr>
<tr>
<td>Coarse Aggregate</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gradation</td>
<td>1/200 CY [150 m³]</td>
<td>1 test per 200 CY [150 m³]</td>
<td>Not Required</td>
</tr>
<tr>
<td>Moisture Content</td>
<td>1 test min</td>
<td>1 test</td>
<td>Not Required</td>
</tr>
<tr>
<td>Fine Aggregate</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gradation</td>
<td>1/200 CY [150 m³]</td>
<td>1 test per 200 CY [150 m³]</td>
<td>Not Required</td>
</tr>
<tr>
<td>Moisture Content</td>
<td>1 test min</td>
<td>1 test</td>
<td>Not Required</td>
</tr>
</tbody>
</table>

(footnotes on next page)
(1) QC cylinders are not required. The contractor is responsible for any concrete cylinder test required for early strength information. Early strength samples can be tested by the contractor or submitted to WYDOT’s Materials Lab for testing.

(2) Take Slump and air content tests with each set of cylinders.

(3) The “1st load” refers to the first truck load delivered on a given day. When a truck is rejected, the following truck will be tested.

(4) A “set” is three cylinders, where the compressive strength is the average of the three cylinders

(5) Frequency of aggregate Quality Control tests may be reduced to 1 test per 200 CY [153 m³] if the aggregate or concrete supplier can demonstrate the following history to the engineer. All tests, and at least 6 tests, for the previous 12 month period shall meet specifications and the gradation and fineness modulus requirements outlined in section 513.4.4.3, Proportioning Portland Cement Concrete Mixes.

513.4.4.3 Proportioning Portland Cement Concrete Mixes

Conduct the AASHTO T303 (ASTM C1260) test or the ASTM C1567 test (when fly ash or silica fume is used in the mix) using a combined sample of fine aggregate and coarse aggregate, in the same proportions that will be used in the concrete mix design and using the cementitious material that is to be used in final concrete mix design. Ensure the test results indicate an expansion at 16 days from casting of 0.10 percent or less.

Mitigate sources which indicate reactive through the use of a Class F fly ash approved for ASR mitigation in accordance with the Materials Testing Manual and/or lithium nitrate additive.

Ensure the AASHTO T303 (ASTM C1260), and ASTM C1567 tests are performed within 12 months prior to the submittal date.

The Department’s Materials Program maintains the option to conduct AASHTO T303 (ASTM C1260) and ASTM C1567 testing for verification.

For Level I Control:

Determine the proportions of the materials, including admixtures, to be used for producing a workable mix having the specified properties for class A concrete.

Prepare a mix design in accordance with the current version of the WYDOT Materials Testing Manual procedure, Section 610.0, Contractor Concrete Mix Design. Submit mix design to the engineer for review a minimum of 14 days prior to the start of concrete placement.
The department’s Materials Program will review the mix design for possible use. Review of a mix design and approval from the department to use a submitted mix design, does not remove the responsibility for the performance of the mix from the contractor.

Base the fresh concrete properties and the compressive strengths on a mix design trial batch. Ensure the minimum 28 day compressive strength for the mix design is 1.15 times the Ultimate Design Strength shown in Table 513.4.4-1. Indicate any special handling or mixing required for admixture introduction. Submit samples of the coarse and fine aggregate, portland cement, fly ash and all admixtures to the engineer with the mix design. Submit for each mix design quantities as listed in Section 513.4.4 Mix Design. Substitute up to a maximum of 20 percent by weight [mass] of fly ash for portland cement when approved by the Department’s Materials Program, based on meeting the required properties for the class of concrete specified. Not less than 1:1 nor greater than 1.33:1 replacement ratio of fly ash to cement is allowed.

Air reducing admixtures are not permitted.

Provide the following information.

1. The intended use of the stabilizer
2. Anticipated haul distance
3. Evaporation control methods after placement

The department maintains the right to run a test batch using the mix design proportions. If the mean 28 day compressive strength of the test batch differs from the submitted mix design strength by more than 200 psi, the department has the following options:

- Accept the mix design as submitted
- Reject the mix design and request a new mix design

Original mix designs may be referenced, or resubmitted for later jobs, as long as the mix design is not more than three years old. Adjust the submitted mix designs for any changes in aggregate absorptions or specific gravities since the original mix design was conducted. Ensure the coarse and fine aggregate gradations of the samples submitted with the mix design are within 10 percent on all specification sieves of those shown on the mix design and the fineness modulus of the fines of the samples submitted with the mix design is within 0.3 of that shown on the mix design. For a given class and type of concrete, the fine aggregate may be adjusted up to 2 percent based on the total weight of aggregate without requiring a new mix design.
A new mix design is required when there is a change in the material source, admixtures, or a change in cement type, or fly ash source.

Submit the mix design results on Form T-100SE [T-100SM] provided in the current version of the WYDOT Materials Testing Manual procedure No. 610.0. The form is to be signed by the contractor and the party responsible for determining mixture proportions and conducting the laboratory trial batch.

For Level of Control II, III, and IV:

The mix designs will be provided by WYDOT’s Materials Program, unless the contractor requests in writing to provide a mix design for approval. Submit component samples in the quantities as listed in Section 513.4.4 Mix Design for each mix design. Ensure the mixes meet the requirements of Table 513.4.4-1, Concrete Class Table.

513.4.4.4 Correlation of Laboratories Performing Mix Designs

Implement the following procedures to control equipment or procedural bias.

1. Make test results from the "AASHTO Materials Reference Laboratory" and "ASTM Cement and Concrete Reference Laboratory" Proficiency Sample available upon request.

2. Provide the mix design test results to the Materials Program. The department will compare contractors and department mix design results using the precision statements in accordance with the Materials Testing Manual.

   The mix design may be approved based on 7 day compressive strength results, if the projected 28 day compressive strengths, or other specified age, are satisfactory.

3. If the differences between the contractor's and the department's test results exceed the precision statements, the department will begin resolving the discrepancy in accordance with section 114.2.3, Resolving Test Discrepancies.
513.4.4.5 Correlation of Field Testing Equipment and Testing Personnel

For Level of Control I, II, and III:

To ensure that no equipment or procedural bias occurs in the test results, perform correlation testing for slump, unit weight and air content. Perform correlation of slump, unit weight and air content tests on a batch of at least 1 cubic yard \([1 \text{ m}^3]\) of concrete with satisfactory results prior to placement of any concrete. The engineer can allow correlation to take place on the first concrete delivered to the project.

513.4.4.6 Correlation of Slump, Air Content and Unit Weight Tests

Discharge sufficient concrete from the mixing unit to perform two sets of slump, air content and unit weight tests, one by the Quality Control technician and one by the Quality Assurance technician. Ensure the differences in test results do not exceed the following values:

- Slump (for 0-4 inch [0-100 mm] slump concrete) 0.5 in [13 mm]
- Slump (for 4-6 inch [100-150 mm] slump concrete) 1.0 in [25 mm]
- Air Content 0.3 %
- Unit Weight 1.0 pcf [15 kg/m\(^3\)]

Enact the dispute resolution procedure if any one pair of the test results exceed the above limits. If both the Quality Control technician’s and Quality Assurance technician’s test results meet specifications, but the results exceed the allowable differences, concrete production may proceed provided that:

1. Dispute resolution procedures commence immediately, and
2. The next load of concrete is tested and the results for both technicians meet specifications.

513.4.4.7 Dispute Resolution for Field Tests

Conduct dispute resolution using the following procedures:

1. Quality Control and Quality Assurance personnel are to meet and review testing procedures, equipment condition, sampling techniques, and
2. Perform the correlation again if cause for bias can be determined and corrected.

3. If the second slump, air content or unit weight tests are not within the allowable difference, area personnel from the Materials Program Independent Assurance section or another party agreed upon by both the contractor and the department will be contacted by the engineer. A third correlation evaluation will be performed with testing being conducted by all three parties. The Independent Assurance (IA) tests results will confirm either the contractor’s or the department’s testing depending on which results the IA results are closest to. If the third party test results verify the contractor’s results, the department will pay for the third party testing. If department’s test results are verified the contractor shall pay for the testing.

513.4.4.8 Additional Correlation

Perform additional correlation during production if either the contractor or the department has reason to believe that either equipment or testing bias is present. A new correlation is required if new testing personnel for either party begins performing tests on the project or if different equipment is used for testing.

Modify Section 513.4.8, Batching, add the following to paragraph 1:

4. Do not allow the total combined weight [mass] of portland cement and fly ash to vary more than 1 percent from the approved mix design.

5. The fine aggregate may be adjusted up to 2 percent based on the total weight of aggregate without the department requiring a new mix design.

Modify Section 513.4.9.1, General as follows:

Add the following paragraph:

10 When stabilizers are used, the maximum placing time requirement and time limit for adding additional water shall be increased by 60 minutes. Apply an evaporation retardant after placement to exposed concrete surfaces which cannot be protected immediately with the curing medium. Prior to use, provide documentation that the
concrete supplier has experience with stabilizers or has been consulted by a manufacturer’s representative on the use of stabilizers.

**Modify Section 513.4.10, Testing, as follows**

Replace paragraphs 1 & 2 with the following:

**513.4.10.1 Independent Assurance**

An Independent Assurance Program will be conducted by the Department’s Materials Program. The program will be conducted in accordance with the Department's Independent Assurance Manual. The differences between Quality Control, Quality Acceptance, and Independent Assurance tests will be evaluated to determine conformance with AASHTO or ASTM Multi laboratory precision statements or Cement and Concrete Reference Laboratory proficiency sample results. If biases are shown, an immediate investigation will be conducted by the department.

**513.4.10.2 Quality Control**

Perform quality control testing. Maintain a quality control system. Ensure the system includes, but not necessarily be limited to, tests for control of aggregate gradation, aggregate moisture content, aggregate deleterious substances, mix temperature, mix consistency (slump), mix air content, yield, and mix compressive strength. Reject concrete which is out of specification based on Quality Control testing.

Perform quality control testing during concrete production and placement at a minimum testing frequency as shown in Table II. Take concrete mixture samples and tests at the concrete placement site.

**513.4.10.2.1 Descriptive Information and Calibration Records**

Make available descriptive information containing information such as make, type, location, and frequency of inspection of the facility. Include frequency and procedures used for checking the mixing unit condition; calibration of weighing and metering devices; verification of calibrations; material storage bins, silos and tanks; and certifications issued for the facility. Include the frequency and procedures used for checking hauling, testing and placing equipment.
513.4.10.2.2 Quality Control Facility and Testing Equipment

Provide and maintain a Quality Control facility for the project and provide a curing facility at the project site conforming to the current edition of the WYDOT Materials Testing Manual procedure No. 606.1.

The type of Quality Control facility is dependent upon the type of placement and the volume of concrete involved, and may be waived by the engineer for smaller projects.

513.4.10.2.3 Aggregate Gradation and Concrete Mixture Quality Control Testing

Gradation:

Determine Coarse and fine aggregate gradations at a minimum frequency as shown for the Level of Control in Table II. Ensure testing is done in accordance with the procedures shown in the current version of the WYDOT Materials Testing Manual procedure no. 602.0.

Temperature, Slump, Unit Weight, Compressive Strength & Air Content:

Conduct tests on the same sample of concrete, at a minimum frequency as shown for the Level of Control requirements in Table II. Take samples in accordance with the current version of WYDOT’S Materials Testing Manual procedure No. 600.0.

Be responsible for the initial curing of concrete cylinders, including Quality Assurance cylinders.

513.4.10.2.4 Documentation and Reporting

Document observations, records of inspection, adjustments to mixture, and test results on a timely basis. Record results of field observations, inspections, and measurements as they occur in a permanent diary. Make records available to the engineer upon request. Submit Quality Control results to the engineer weekly.

513.4.10.2.5 Control Charts

Maintain and display control charts for each class of concrete, and for each mix design. Record Quality Control test results on the control chart immediately upon completion of the test or receipt of the test results, but in no case later than the end of the day the test is completed. Record the following parameters on the control charts:

1. Coarse Aggregate Gradation
2. Fine Aggregate Gradation  
3. Coarse Aggregate Moisture Content  
4. Fine Aggregate Moisture Content  
5. Fine Aggregate Fineness Modulus  
6. Slump  
7. Air Content  
8. Water/cement or water/cement + fly ash ratio  
9. Specification Limits  

Record and keep current the following additional data:  

1. Organic Impurities in Fine Aggregate  
2. Mix Compressive Strength  
3. Mix Temperature  
4. Yield or Unit Weight  

Display data and control charts in a location which is accessible during working hours for review by the engineer.

The Control Chart requirement may be waived by the engineer for smaller projects.

513.4.10.2.6 Corrective Action Process

Immediately notify the engineer if mix adjustments are to be made. The department’s Materials Program will review the proposed changes and determine if a new mix design is required.

A new mix design is required when:

1. A change in fine aggregate fineness modulus of more than 0.3 from the initial mix.  
2. A change in fine aggregate and coarse aggregate splits of more than 2 percent based on the total weight of aggregate per cubic yard [meter].  
3. When the compressive strengths of more than 10 percent of the cylinders, and at least 4 cylinders, are below the specification minimum.  

Make immediate adjustment in batch water addition based on changes in the aggregate stockpile moistures.
513.4.10.2.7 Quality Control Information

For Levels of Control I, II, and III, a minimum of 14 days prior to production, submit the following information in writing to the engineer for approval.

- Information and calibration records as described in subsection 513.4.10.2.1 Descriptive Information and Calibration Records

- An organizational chart indicating lines of authority for Quality Control for all aspects of the concrete construction. The names, phone numbers and qualifications of the personnel responsible for the contractor’s Quality Control Program, including the Quality Control Supervisor and a listing of the Certified Technician(s) responsible for the quality control testing shall be shown. The organization that will perform the mix design and its qualifications, address, phone number and responsible party.

- Description of the testing equipment, the on-site curing facility, and the location of the Quality Control facility.

- Sampling procedures and techniques to be used. Include how sample times or locations are determined, how samples are collected for testing, how the calibration is accomplished for sampling devices and how mix design samples are to be collected.

- Method of initial curing of cylinders.

- Types of anticipated on site admixtures and the personnel who will have the authority to redose a batch. State whether the use of a stabilizer is anticipated.

- Location where control charts are to be displayed.

- A set of rules that determine what corrective actions will be taken when the material properties are near the specification limits.

513.4.10.3 Quality Acceptance

The department will perform Quality Acceptance testing.

The department’s Materials Program will transport the quality acceptance cylinders to the Department’s Material Testing Laboratory in Cheyenne. Level I Control Cylinders may be tested at an alternate testing facility when agreed upon by the engineer and the contractor. The facility testing cylinders for Level I control must be different than the
facility testing the contractor’s cylinders. The engineer will transport the quality acceptance cylinders to other testing facilities. Provide a safe environment for collecting the samples.

Final Acceptance is based on the following:

1. Comparison of the engineer’s quality assurance test results with specification limits using independent samples obtained randomly (except where otherwise noted) for:
   a. Slump
   b. Air Content
   c. Fine aggregate gradation
   d. Coarse aggregate gradation
   e. Compressive strength

When compressive strength test specimens are made, slump and air content tests along with unit weight and temperature determinations are be made, all from the same sample of concrete.

Stockpile moisture contents may be tested by the engineer for comparison to the moisture test results being used to adjust batch water and determine the water/cement or water/cement + fly ash ratio.

For any Level of Control, concrete with the slump outside the specification limits will be cause for rejection of the load of concrete. Make immediate adjustments to the mixture.

The engineer has the option to test and reject material that is obviously outside of specification limits.

2. For Level I Control, the engineer will determine a pay factor on each lot based on independent samples for:
   a. Air content
   b. Compressive strength

A pay factor determination is made when there is sufficient quantity to provide the minimum number of test results required to constitute a lot. Partial lot test results will be included with the previous lot for analysis.
3. For Level II & III Control, the engineer will determine a pay factor on each quality acceptance sample. The pay factor will be applied to the volume of concrete represented by each sample. Per Table II, the maximum amount of concrete represented by an individual sample is 100 CY. The amount of concrete represented by each sample is dependent on the sampling frequency. The volume of concrete represented by each sample is the volume of concrete placed since the previous Quality Acceptance test. If a Quality Acceptance test is not taken for the final load, use the pay factor from the last Quality Acceptance test taken.

4. For Level IV Control, the engineer will accept/reject with no pay factor.

513.4.10.3.1 Definition of Lot and Sublot

For Level of Control I, acceptance of compressive strength and air content is based on lots. Each lot will be analyzed individually. Lots will be a maximum of 150 CY [115 m³]. The actual size of the lots shall be agreed upon, prior to placement.

The number of sublots in a lot will be as shown below:

<table>
<thead>
<tr>
<th>Lot Size</th>
<th>Sublots per Lot</th>
</tr>
</thead>
<tbody>
<tr>
<td>120 CY to 150 CY [92 to 115 m³]</td>
<td>5</td>
</tr>
<tr>
<td>90 CY to 120 CY [70 to 92 m³]</td>
<td>4</td>
</tr>
<tr>
<td>Less than 90 CY [70 m³]</td>
<td>3</td>
</tr>
</tbody>
</table>

In order to achieve better sample representation, the number of sublots per lot may be increased by a maximum of two as determined by the engineer.

Each sublot is represented by 3 cylinders for compressive strength, and 1 test for air content.

The lot size is controlled by the volume of concrete placed. A lot may span several days of placement.

513.4.10.3.2 Quality Acceptance Sampling

For Level I control pumped concrete take samples after pumping and before screeding, as directed by the engineer. Concrete samples are taken in a manner representative of the material being placed.
For all other concrete, including pumped concrete, the take samples upon discharge of the material from the haul truck as directed by the engineer except as noted below.

For Level of Control II and III, the contractor has the option of sampling at the end of the pump line. If the samples are taken after the pump, the sampling requirements for Level I will apply and the air content pay factor for Level of Control II and III (Non-pumped concrete) will apply instead of Level of Control II and III (Pumped concrete, sampled before the pump).

Take gradation samples, in the presence of the engineer.

513.5 MEASUREMENT and PAYMENT

Add the following:

<table>
<thead>
<tr>
<th>Pay Item</th>
<th>Pay Unit</th>
<th>Measure to the Nearest</th>
<th>Pay to the Nearest</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contractor Quality Control (Concrete)</td>
<td>LS</td>
<td>LS</td>
<td>LS</td>
</tr>
</tbody>
</table>

Payment for the Contractor Quality Control (Concrete) testing will be made at the contract Lump Sum bid price. Twenty-five percent (25%) of the Lump Sum bid price for the Contractor Quality Control testing will be paid on the first monthly estimate. Fifty percent (50%) of the Lump Sum bid price will be paid on the monthly estimate for the month in which the testing begins. The final twenty-five percent (25%) will be paid upon completion of the Contractor Quality Control Testing Item. Additional compensation will not be made for additional testing required due to minor increases in quantities of contract items in this specification. Changes in quantities meeting the changed condition requirements specified in Subsection 104.02, Contract Amendment will be sufficient justification for further adjustment.

513.5.2, Determination of Pay Factors

Pay accepted quantities in accordance with the following evaluation:

COMPRESSIVE STRENGTH

a. Determine Individual Pay Factors:

\[ PF_{cs} = 2 \left( \frac{X}{f'c} \right) - 1, \text{ where } PF_{cs} \leq 1.0 \]
PFcs = Compressive Strength Pay Factor rounded to the nearest 0.01
\( f'_{c} \) = Specified Compressivc Strength from the Contract.
X = 28 Day Compressive Strength (Average of 3 cylinder tests) rounded to the nearest 1.0 psi.

For Level of Control I, X represents average Compressive Strength of the Lot, which is the average of the subplot strengths.

Level of Control I

Material represented by a subplot compressive of less than 0.85 \( f'_{c} \) will be rejected. Reject either the entire subplot or, if test information is available, a portion of the subplot which can be defined by the volume of material placed between two consecutive Quality Control tests which meet specifications, and were taken before and after the Quality Acceptance test.

The pay factor will apply to the quantity of material represented by the entire lot.

Level of Control II and III

Material represented by the test with a pay factor less than 0.75 will be rejected.

The pay factor will apply to the quantity of material represented by each test.

AIR CONTENT

a. Determine Individual Pay Factors:

For Level 1 Control

Air Content (PFa):

\[ PFa = 1.0 - (0.1)(3/N)[ (4.2 - AC_1) + (4.2 - AC_2) + \ldots + (4.2 - AC_N) ] \]

Where \( AC_1 \) = Air content for subplot #1 in percent, etc.

If \( AC_n \geq 4.2 \), Use \( AC_n = 4.2 \) in equation.

\( N = \) Number of sublots in a lot
Max PFa = 1.0

Sublots with AC < 3.5% will be rejected and not included in this calculation. Reject either the entire sublot or, if test information is available, a portion of the sublot which can be defined by the volume of material placed between two consecutive Quality Control tests which meet specifications, and were taken before and after the Quality Acceptance test.

**Level of Control II and III (Non-pumped concrete)**

Air Content (PFa):

\[
PFa = 1.0 - (0.3)(4.2 - AC)
\]

Where

- AC = Air content in percent
- If \( AC \geq 4.2 \), Use AC=4.2 in equation.

Max PFa = 1.0

AC < 3.5% will be rejected

**Level of Control II and III (Pumped concrete, sampled before the pump)**

Air Content (PFa):

\[
PFa = 1.0 - (0.3)(4.7 - AC)
\]

Where

- AC = Air content in percent
- If \( AC \geq 4.7 \), Use AC=4.7 in equation.

Max PFa = 1.0

AC < 4.0% will be rejected
Pay adjustments for compressive strength and air content will be calculated using the following formula:

Compressive Strength/Air Content:

\[ PA_{CSAC} = CLP \times (PF_{FINAL} - 1) \]

Where:

- \( PA_{CSAC} \) = Pay Adjustment for Compressive Strength/Air Content (dollars)
- \( CLP \) = Appropriate Concrete Bid Item Price (dollars)
- \( PF_{FINAL} \) = Minimum of PFcs and PFa

Pay factors will be rounded to the nearest one-hundredths place.

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