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## HYDRAULIC CEMENTS

### GENERAL

Portland Cement shall meet the requirements of ASTM C-150 for the type specified. When blended cement is to be furnished, it shall meet the requirements of ASTM C-595. Cement Type I, II, III, IP, and IS shall also meet the additional requirements outlined in Section 4101 of the Standard Specifications. Approval of any type of Portland and blended cements will be based on certification by an approved plant or upon source sampling and testing before being incorporated into the work. Cement sampling and testing will be used only for establishing a basis for plant approval or for unusual situations. Approved cement producers and distribution terminals are listed in the Appendixes of this IM.

### AVAILABLE CEMENT TYPES

#### ASTM C150

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|----------|---|
| Type I   | For general use.  |
| Type II  | For moderate sulfate resistance. $C_3A$ less than 8%          |
| Type III | High early strength. Generally, a finer ground Type I cement. |

#### ASTM C595

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|---------|--|
| Type IS | Type I Slag is a Portland cement blended, or clinker interground, up to 95% GGBSF.       |
| Type IP | Type I Pozzolan is a Portland cement blended or clinker interground, up to 40% pozzolan. |

### WHITE CEMENT

White cement sources shall meet the requirements of ASTM C150, except the maximum  $Fe_2O_3$  shall not exceed 0.5%. Approved sources of white cement are listed in the Appendix B.

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## **SAMPLING & TESTING**

Samples will be taken of the cement while in storage, or at time of manufacture. Samples will be secured of each 400 tons (400 Mg) or less, from a given lot. A lot is considered an identified unit of cement, such as a bin or silo. Acceptance may be on the basis of time of set, fineness, soundness and air content or mortar, if other tests continuously meet the requirement of the specifications. Cement shall not be incorporated until the above-mentioned test results and certified mill test data are available. Each shipment shall be accompanied by two copies of an invoice or bill of lading, which bear a statement by the producer, attesting to the type of cement, lot number, quantity, and transport tanker number.

## **PLANT CERTIFICATION**

### A. Accepted Quality Control Program

The sampling and testing frequency shall be that which the District Materials Engineer considers necessary for proper quality control. The control of the production from each grinding mill type shall be considered separately. The following minimum testing frequencies are presented as a general guideline:

1. One sample representing 24 hours of production to be tested for air content, false set, and soundness. Determinations of free lime may be used to alter the frequency of testing soundness.
2. One sample representing 4 hours production to be tested for time of set and fineness.
3. One sample representing 48 hours production to be tested for chemical analysis.
4. One sample representing 4 day's production to be tested for 3- and 7-day compressive strength.

The sampling, tests and testing frequencies required may vary from the above guidelines depending of the particular production problems of the plant. In all cases, the quality control procedure used shall be submitted in writing to the District Materials Engineer for approval.

The plant sample test records shall be available for study by Highway Division personnel for at least seven years after the cement represented has been produced.

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B. Control Laboratory Approval

The Portland Cement plant is required to have a control laboratory complaint with ASTM C1222, Standard Practice for Evaluation of laboratories Testing Hydraulic Cement. This laboratory will perform testing on the applicable types of cement produced (ASTM C150/AASHTO M85, C595/AASHTO M240, C1157) and shipped for consumption for Iowa DOT projects. A control laboratory will be considered approved if it is properly equipped and staffed to perform tests required for an accepted Quality Control Program. AASHTO accreditation for hydraulic cement testing of the applicable cement types is acceptable. Continued approval of the control laboratory will depend on the comparison of its test results with those of the Highway Division Ames Laboratory. If major differences are found, an attempt to resolve them should be made as quickly as possible. Continued unresolved differences in test results will be considered a basis for discontinuing control laboratory approval.

C. Monitor Sampling/Testing at Production Plant or Distribution Center of a Regular Supplier

A **Regular Supplier** is one that furnishes cement to Iowa DOT or other public roads projects on a regular and continual basis. To establish an initial quality control history, the production of cement from the plant of a Regular Supplier shall first be sampled at the rate of 1 sample per 400 tons (400 Mg) until 20 samples have been tested. For a cement plant located outside of Iowa, test results of host state transportation agency may be accepted for establishing the 20-sample history. Otherwise, 20 samples can be taken at an Iowa terminal where the cement is stored before shipping to a project. After establishing the 20-sample history, random samples shall be obtained at the rate of one sample per lot. However, per the approval of the District Materials Engineer, the rate of these random samples may not exceed one sample per month. Whenever possible, these random samples shall be obtained from the production plant. If it is not practical to sample from the production plant, random samples may be obtained from bins at a distribution terminal of the Regular Supplier. A lot is considered to be 10,000 tons (10,000 Mg) of certified production. Iowa-certified cement at a distribution terminal of a Regular Supplier shall be sampled and tested at a minimum rate of one sample each calendar quarter.

A sample shall be obtained from the plant of a Regular Supplier twice a year, preferably in January and July. The sample will be split and tested for complete chemical and physical properties by supplier's control laboratory and the Highway Division Ames Laboratory, respectively. The date of the split sampling and load out silo number will be identified on the sample identification report for later comparison.

D. Monitor Sampling/Testing at Production Plant and Distribution Terminal of an Intermittent Supplier

An **Intermittent Supplier** is one that furnishes cement to Iowa DOT or other public roads projects in small quantities and at irregular intervals.

Establishment of initial quality control history of an Intermittent Supplier shall be the same as that required of a Regular Supplier.

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If the plant is making shipments directly from the plant to Iowa DOT or other public roads projects, samples of that cement shall be obtained and tested a minimum of once each calendar quarter.

Cement at a distribution terminal of an Intermittent Supplier shall be sampled and tested at the minimum rate of one sample each calendar quarter or prior to use.

#### E. Quality Control

If a producer's quality control sample of a monitor sample test result exceeds the established critical limits, additional samples shall be taken of the lot represented at the rate of 1 sample per 400 tons (400 Mg). This sampling rate shall continue until 2 consecutive test results fall within the critical limits, at which time the sampling rate may be reduced to the sampling rate shown above. The producer shall immediately advise the District Materials Engineer responsible for monitoring the plant, when critical limits have been exceeded.

#### F. Co-mingling of Cement

Mixing of cement from different sources, different plants, or of different types in one storage bin or silo will not be allowed.

At ready mixed concrete plants and paving batch plants, a cement storage bin shall be emptied, as far as practical, prior to refilling from a different source. Type IP or Type IS cement shall be stored in bins not used for Type I, II, or III cement.

#### G. Addition of Limestone

Up to 5% of limestone by mass is permitted in amount such that the chemical and physical requirements described in ASTM C150 are met. When limestone is used, the manufacturer shall inform the Office of Materials in writing on the amount of the addition. The manufacturer shall also supply comparative test data on chemical and physical properties of the cement with and without limestone. The amount of limestone used shall be included in the manufacturer's Mill Test Reports.

#### H. Mill Test Reports

Mill Test Reports covering cement to be certified shall be submitted to the Cement and Concrete Engineer at the Central Laboratory at Ames, and if requested, to the District Materials Engineer who monitors the plant. In addition, the alkali equivalent for the clinker used in production of Type IP and IS cements shall be submitted to the Cement and Concrete Engineer.

An electronic form (Excel spreadsheet) is acceptable.

The plant of a regular supplier is required to submit reports for ASTM C917, Standard Test method for Evaluation of Cement Strength Uniformity at least semiannually.

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I. Removal from Approved List

A producer that does not supply Iowa's state or county projects during a three consecutive year period shall be removed from the list of approved sources of Portland cement.

J. Type IP and IS for Patching Applications

Type IP and IS may be approved for patching provided the following criteria is met:

Compressive strength for a five hour Class M patching mix, using the blended cement, shall be equal to or greater than the compressive strength achieved using the same mix with the Type I/II cement used to produce the blended cement.

K. Certification By Other States

Iowa DOT will accept cements and cement blends certified by other state transportation agencies, providing the process complies with the following agreement.

1. The host state agency will require the cement plant within its boundaries to have a laboratory compliant with ASTM C1222, Standard Practice for Evaluation of Laboratories Testing Hydraulic Cement. This laboratory will perform testing on the applicable types of cement produced (ASTM C150/AASHTO M85, C595/AASHTO M240, C1157) and shipped for state agencies consumption. AASHTO accreditation for hydraulic cement testing of the applicable cement types is acceptable. Agency laboratories used for verification testing must meet the same criteria.
2. The host state agency will require the cement plant within its boundaries to have a printed, agency acceptable quality control/quality assurance plan for the production of cements used by state agencies. The plan must include commitments to comply with ASTM C1222 and ASTM C183, Standard Practice for Sampling and the Amount of Testing of Hydraulic Cement. The host state agency will verify compliance with the quality control plan.
3. The host state agency will require the cement producer to maintain and provide, for each lot (silo) of cement shipped, a compilation of Mill Test Reports in an electronic form (Excel spread sheet). The applicable data will be provided to the host state agency at least semiannually.
4. The host state agency will require the cement producer to submit split samples of a regular Portland cement (ASTM C150/AASHTO M85) and a blended cement (ASTM C595/AASHTO M240) or performance specification cement (ASTM C1157) if produced, semiannually for verification testing.
5. The host state agency will require the cement producer to submit reports for ASTM C917, Standard Test Method for Evaluation of Cement Strength Uniformity From a Single Source, for both a regular Portland cement and a blended cement, if produced, at least semiannually.

6. The host state agency will require the cement producer to maintain production and quality control/quality assurance records for at least seven years and make those records available if requested.
7. The host state agency will review submittals from the cement producer along with agency test results. If deficiencies are discovered, the state agency will monitor corrective actions taken by the producer until the deficiencies are corrected. The reciprocal agreement state agency will be notified of the deficiencies and of each occurrence.
8. Any test results or submittals collected by the host state agency may be made available to the reciprocal agreement state agency upon request.
9. All cement plant information and data is confidential within the limits of a public agency and is for state agencies information and inspection only.
10. Quality assurance test results of field samples, performed by a reciprocal state, shall be reported to the host state agency when non-compliance occurs. The reciprocal state agency will deal directly with the cement producer. The host state agency will take action as described in Item 7. The host state agency shall notify all reciprocal agreement state agencies when non-compliance occurs.
11. Cement tests or requirements beyond the standards stated above may be provided to reciprocal state agencies by agreement between the host state and reciprocal state agencies.

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**CERTIFICATION DOCUMENTS**

The producer of certified cement shall furnish for the project records, two invoices or bill of lading copies, which bear the following certification statement and the signature of a responsible company representative:

**CERTIFICATION STATEMENT**

The material herein described has been sampled and tested as prescribed by the Highway Division of the Iowa Department of Transportation and complies with the applicable specification requirements for type \_\_\_\_\_ cement.

Bin No. \_\_\_\_\_ Signed \_\_\_\_\_  
Date \_\_\_\_\_

The bills of lading or invoices shall include project number, if available, source name, source location, source code, type, and quantity in the shipments. For blended cements (Types IP and IS), the above type designation shall include the suffix (X), where (X) equals the targeted percentage of slag or pozzolan in the product.

In the case of truck shipments, these copies of the bill of lading or invoice shall accompany each load, and shall be retained at the project or ready mixed concrete plant for the project engineer records. In the case of rail shipments, these copies shall be mailed to the project or ready mix plant.

The truck tanker shall have a copy of the invoice or bill of lading attached directly to the tanker portion of the truck. When the tanker unloads the contents at the project site, the unloading time and material final destination (storage "pig" number) shall be marked on this copy and left with the invoice or bill of lading copies.

In the case of more than one project being supplied by a ready mixed concrete plant, the plant shall furnish the project engineer, for each project, either a copy of each bill of lading or invoice, or a listing of the bills of lading or invoices representing the cement incorporated in the project. This listing shall bear the signature of a responsible plant representative.

**PROJECT DOCUMENTATION**

The manufacturer, car or truck number, ticket number, cement type, and quantity of each shipment of cement used on a project shall be recorded on Form #830211, or Form #830224, whichever is applicable. In the case of paving, recording the first and last ticket for cement received each day on the Form #830224 will be sufficient.

**PROJECT ASSURANCE SAMPLING**

Assurance samples will be secured at the project site just before incorporation into the work. Test results, which do not comply with the specifications, may be considered sufficient cause to rescind approval to furnish cement on a certification basis. Construction that contains cement represented by assurance samples showing deficient test results, will be subject to the requirements of Article 1105.04 of the Standard Specifications.