PORTLAND
CEMENT
CONCRETE

REFERENCE MANUAL
2007-2008

TECHNICAL TRAINING AND CERTIFICATION PROGRAM

Iowa Department
of Transportation

PORTLAND CEMENT CONCRETE REFERENCE MANUAL

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Iowa Department of Transportation

Office of Materials

April 20, 2004
Supersedes April 27, 1999

Matls. IM 203

CONSULTATION PROVIDED BY MATERIALS PERSONNEL ON CONSTRUCTION PROJECTS

INTRODUCTION

In addition to the routine duties associated with the inspection of materials, assurance sampling and testing, and certain laboratory operations, the District Materials Engineer (DME) is required to monitor Quality Control and acceptance procedures, and provide consultation when difficulties are encountered.

CONSULTATION

Plant inspectors are by instruction required to consult the DME through the Resident Construction or County Engineer when the contractor encounters difficulty with regard to specification compliance and satisfactory plant operations. Consultations are also required when technical problems become evident to personnel performing sampling and testing and other specialized functions. The DME should provide the necessary assistance and guidance when conditions indicate action is required.

GUIDELINES FOR CONSULTATION

In many cases plant equipment operation and maintenance practices are directly related to problems associated with the work. Materials handling and storage procedures also cause difficulty at times. Sampling, testing and related inspection functions require re-evaluation when difficulties are encountered on a project. The following guidelines should be observed when Materials personnel are consulted for guidance:

1. Determine who is responsible for the problem and advise the appropriate party.

2. If the difficulty is associated with sampling, testing or related inspection functions provide the necessary guidance or instruction if practical and advise the engineer in charge of action taken.

3. If the difficulty is associated with the contractor's equipment or procedures, reaffirm the responsibility and requirements assigned to the contractor by the contract documents. The DME should then assist the contractor in identifying the problem by performing additional tests, calibrations, or other measurements as provided for in the specifications and appropriate instructions.

4. In the event that the standard procedures do not properly identify the factors causing the difficulties encountered, the DME may provide additional guidance, if requested, with the clear understanding that such further consultation will not relieve or reduce the contractor's responsibility for solving problems associated with the work. Assistance so provided shall not include management services associated with the operation and maintenance of the contractor plant equipment and the direction of the contractor personnel.

GENERAL REWRITE – PLEASE READ CAREFULLY.

INSPECTION OF CONSTRUCTION PROJECT SAMPLING & TESTING

INTRODUCTION

The Iowa Department of Transportation (DOT) has established a Quality Assurance Program (IM 205) to assure that the quality of materials and construction workmanship incorporated into all highway construction projects is in reasonable conformity with the requirements of the approved plans and Specifications, including approved changes. It consists of an Acceptance Program and an Independent Assurance Program (IAP), both of which are based on test results obtained by qualified persons and equipment.

The acceptance portion of the program covers quality control (QC) sampling and testing and verification sampling and testing. The IAP portion of the program covers the evaluation of all sampling and testing procedures, personnel, and equipment used as part of an acceptance decision (includes Contractor, Contracting Agency, and consultant).

ACCEPTANCE PROGRAM FOR MATERIALS

To fulfill the materials acceptance requirements, several methods are used by the DOT.

Sampling & Testing (Test Report)
Certification
Approved Sources
Approved Shop Drawings
Approved Catalog Cut
Fabrication Report
Visual Approval by the Engineer

In many cases more than one method may be required for acceptance in the 204 Appendices and tables in the back of this guide. For some new or special materials, the Materials Engineer may need to determine the most appropriate acceptance requirements.

In order to provide the Contractor the opportunity to construct a project with minimal sampling and testing delays, inspection is performed at the source for many materials. Source inspection may consist of inspecting process control, sampling for laboratory testing or a combination of these procedures. All source-inspected or certified materials are subject to inspection at the project site prior to being incorporated into the work. Project site inspections are for identification of materials with test reports and for any unusual alterations of the characteristics of the material due to handling or other causes. Verification samples secured by project Agency personnel of source-inspected, certified, or project processed materials are also required for some materials in order to secure satisfactory validation for acceptance.

When certification procedures are required, the Contractor may, on the Contractor's own responsibility and at the Contractor's risk, incorporate these materials into the work. Acceptance will be based on satisfactory certification and compliance of the test results of any verification samples. When verification samples are not required, acceptance will be based on satisfactory certification.

A. SAMPLING & TESTING (TEST REPORT)

When a material is sampled and tested, the results will be documented on a construction form or a test report. There is quality control sampling and testing done by the Contractor or producer and verification sampling testing done by the Project Engineer, the District Materials Engineer, the Central Materials Laboratory, or an independent laboratory.

In many cases, in addition to sampling and testing, some other type of acceptance method will also be required. Sampling and testing may be done at the project, supplier, or source depending on which is the most appropriate.

B. CERTIFICATION OF COMPLIANCE

For many materials a fabricator, manufacturer, or supplier is required to provide the Project Engineer with a certification document stating that the material meets the requirements of the plans and specifications. In most cases, the fabricator, manufacturer, or supplier must also be on an approved list in the IM. For some of these materials, sampling and testing is also required before final acceptance. The certification comes in a variety of forms:

- Stamped or preprinted on truck tickets as with aggregates,
- Stamped or preprinted on invoices as with Portland Cement and asphalt binder,
- Stamped or printed on the Mill Analysis as with reinforcing steel, structural steel, and other metals,
- Furnished as a separate document with each shipment as with zinc-silicate paint, engineering fabrics, epoxy coatings, and dowel baskets,
- Stamped or printed on a list of materials for each shipment as with CMP, concrete pipe, clay tile, and corrugated plastic subdrain,
- In the form of a guaranteed analysis as with seed labels.

The inspector will verify that the certification has been received by documenting it in the project materials book. Certifications are Type A, Type C, Type D, or other type as required by the Engineer or IM.

Type A Certification

A Type A certification is a laboratory report with test results and a certification statement stating that the materials furnished comply with the specifications. The tests may be conducted in the manufacturer laboratory or another qualified laboratory. The test samples must be from the lots of material shipped.

Type C Certification

A Type C certification is a paper prepared by the manufacturer or producer stating that the materials furnished are in accordance wit the specifications. The applicable specification article or Office of Materials IM number is identified in the certification.

Type D Certification

A Type D certification is a letter or paper prepared by an approved manufacturer stating that the materials furnished comply with the applicable specifications of the Iowa Department of Transportation.

C. APPROVED SOURCE

(May also be referred to as "Approved Producer, Approved Supplier, Approved Fabricator, or Approved Brand") The source, producer, and the material must be evaluated and approved by the Office of Materials according to the appropriate Office of Materials IM in order to be used on a project. Once a letter of approval is issued, the source or producer is approved for use on projects (with the exception of steel fabricators). Approved lists are issued biannually for general information only. Approval for a source or producer may be rescinded at any time if it no longer meets the requirements of the IM.

The project inspector will document information about this material such as product name, source, date, producer, and lot number in the project materials book.

Most approved sources also require a certification.

D. APPROVED WAREHOUSE STOCK

For some items made up of miscellaneous materials, inspection and approval will be done by the District Materials Engineer at the supplier's warehouse.

E. APPROVED SHOP DRAWING & APPROVED CATALOG CUT

This information must be submitted to, and reviewed by the Iowa DOT Central Design Offices, before the material can be incorporated in the project.

F. FABRICATION REPORT

The project inspector must have a copy of the final fabrication report prior to incorporating the item into the project. The report will vary depending on the Materials IM requirements for the item fabricated. Final acceptance is by construction personnel at the project site, and is based on the proper documentation and the condition of the component.

G. VISUAL APPROVAL BY PROJECT ENGINEER

(May also be referred to as "As Per Plan, Approved By RCE, or Manufacturer Recommendations") The project inspector must document information about this material such as product name, source, producer, lot number and date produced in the project materials book. The inspector will make sure the material meets the requirements of the plans, the Engineer, or the manufacturer before the material is used. Visual approval requires construction personnel to visually inspect the material to determine if it complies with the specifications. Visual approval is appropriate for non-critical items such as mulch or sod stakes, where compliance can be readily determined by visual means. If there are questions on specification compliance, samples will be taken for testing.

INDEPENDENT ASSURANCE PROGRAM

The IAP evaluates all sampling and testing procedures, personnel, and equipment used as part of an acceptance decision (Includes Contractor, Contracting Agency, and consultant). Independent assurance includes evaluation based on:

Calibration checks
Split samples
Proficiency samples
Observation of sampling and testing performance

The test method and the frequency of test are in the Appendices. Calibration checks and proficiency samples testing is covered in IM 208.

SMALL QUANTITIES

Refer to Appendix X.

IM 204 Appendixes

Appendix A	Roadway & Borrow Excavation & Embankments
Appendix B	Soil Aggregate Subbase
Appendix C	Modified Subbase
Appendix D	Granular Subbase
Appendix E	Portland Cement Concrete Pavement, Pavement Widening, Base Widening, Curb & Gutter & Paved Shoulders
Appendix F	Hot Mix Asphalt (QMA)
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Appendix M	Concrete Bridge Floor Repair & Overlay & Surfacing
Appendix P	Surface Treatment (Seal Coat, Slurry, Joint Repair, Crack Filling & Fog Seal)
Appendix T	Base Repair, Pavement Repair
Appendix U	Granular Shoulders
Appendix V	Subdrains
Appendix W	Water Pollution Control, Erosion Control
Appendix X	Acceptance of Small Quantities of Materials
Appendix Z	Supplemental Guide, Basis of Acceptance

Sampling & Testing Guide-Minimum Frequency

October 16, 2007
Supersedes October 17, 2006

ROADWAY & BORROW EXCAVATION & EMBANKMENTS

Section 2102 & 2107

Matls. IM 204
Appendix A (US) Units

MATERIAL OR CONSTRUCTION ITEM	TESTS	METHOD OF ACCEPTANCE & RELATED IMs	QUALITY CONTROL					INDEPENDENT ASSURANCE & VERIFICATION S&T						REMARKS
			SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	S&T TYPE	SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	
SOURCE INSPECTION														
Special Backfill														
Crushed Stone (4132.02)		AS 209												
Crushed Concrete (4132.02)		209												
RAP (2303.02) Gravel (4132.03)		AS 209												
Granular Backfill		AS 209												
Engineering Fabric (4196)	Quality	AS 496.01												
GRADE INSPECTION														
Special & Select Backfill Compaction Control	Moisture	309, 310						V	RCE	1/lift/ 1500 ft.	1 lb	RCE	Field Book	
Moisture & Density Compaction Control	Density (Proctor) Moisture	309, 310						V	RCE	1/soil class 1/lift/1500 ft.	25 lb 1lb	RCE	Field Book	
Compacted Materials	Density	311, 326, 334						V	RCE	1/lift/mile or 1/1500 cy		RCE	Field Book	Unless otherwise specified or directed

AS-Approved Source
ASD-Approved Shop Drawing
S&T-Sampling & Testing

Cert A-Type A Certification
Cert C-Type C Certification
Cert D-Type D Certification

RCE-Resident Construction Engineer/Project Engineer
DME-District Materials Engineer
CTRL-Central Materials Office
CONTR-Contractor

IA-Independent Assurance
V-Verification

Sampling & Testing Guide-Minimum Frequency

October 16, 2007
Supersedes October 17, 2006

ROADWAY & BORROW EXCAVATION & EMBANKMENTS

Section 2102 & 2107

Matls. IM 204
Appendix A (Metric) Units

MATERIAL OR CONSTRUCTION ITEM	TESTS	METHOD OF ACCEPTANCE & RELATED IMs	QUALITY CONTROL					INDEPENDENT ASSURANCE & VERIFICATION S&T						REMARKS
			SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	S&T TYPE	SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	
SOURCE INSPECTION														
Special Backfill														
Crushed Stone (4132.02)		AS 209												
Crushed Concrete (4132.02)		209												
RAP (2303.02) Gravel (4132.03)		AS 209												
Granular Backfill		AS 209												
Engineering Fabric (4196)	Quality	AS 496.01												
GRADE INSPECTION														
Special & Select Backfill Compaction Control	Moisture	309, 310						V	RCE	1/lift/ 450 m	0.5 kg	RCE	Field Book	
Moisture & Density Compaction Control	Density (Proctor) Moisture	309, 310						V	RCE	1/soil class 1/lift/450 m	12 kg 0.5 kg	RCE	Field Book	
Compacted Materials	Density	311, 326, 334						V	RCE	1/lift/1.5 km or 1/1150 m^3		RCE		Unless otherwise specified or directed

AS-Approved Source
ASD-Approved Shop Drawing
S&T-Sampling & Testing

Cert A-Type A Certification
Cert C-Type C Certification
Cert D-Type D Certification

RCE-Resident Construction Engineer/Project Engineer
DME-District Materials Engineer
CTRL-Central Materials Office
CONTR-Contractor

IA-Independent Assurance
V-Verification

SOIL AGGREGATE SUBBASE

Section 2110

MATERIAL OR CONSTRUCTION ITEM	TESTS	METHOD OF ACCEPTANCE & RELATED IMs	QUALITY CONTROL					INDEPENDENT ASSURANCE & VERIFICATION S&T						REMARKS
			SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	S&T TYPE	SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	
SOURCE INSPECTION														
Granular Surfacing Material (4120)		AS 209												
GRADE INSPECTION														
Mixed Materials (2110)	Density (Proctor)	309						V	RCE	2/mile (min. 2/proj.)	5000 gm	RCE	Field Book	Change of Soil type requires additional Proctors
Uncompacted Mixture	Pulverization Moisture	2" Sieve Visual						V	RCE	2/mile		RCE	Field Book	
Compacted Mixture (2110)	Density Thickness Width	311, 312, 334 337						V	RCE	2/mile		RCE	Field Book	
Finished Subbase	Cross Section	Stringline						V	RCE	10/mile		RCE	Field Book	Template for secondary park & institutional roads

AS-Approved Source
ASD-Approved Shop Drawing
S&T-Sampling & Testing

Cert A-Type A Certification
Cert C-Type C Certification
Cert D-Type D Certification

RCE-Resident Construction Engineer/Project Engineer
DME-District Materials Engineer
CTRL-Central Materials Office
CONTR-Contractor

IA-Independent Assurance
V-Verification

Sampling & Testing Guide-Minimum Frequency

October 17, 2006
Supersedes October 18, 2005

MODIFIED SUBBASE
Section 2115

Matls. IM 204
Appendix C (US) Units

MATERIAL OR CONSTRUCTION ITEM	TESTS	METHOD OF ACCEPTANCE & RELATED IMs	QUALITY CONTROL					INDEPENDENT ASSURANCE & VERIFICATION S&T						REMARKS
			SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	S&T TYPE	SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	
SOURCE INSPECTION														
Natural Aggregate	Quality Gradation	AS 209												
Recycled Products														
Composite	Gradation	*As Per Spec.												
PCC Pavement	Gradation	*As Per Spec.												
Rap		*As Per Spec.												
GRADE INSPECTION														
Compacted Subbase	Density	*As Per Spec.						V	RCE			RCE	Field Book	
Dimensions	Thickness Width	337						V	RCE	3/2 lane mi.		RCE	Field Book	
	Cross Section (Primary)	Stringline						V	RCE	10/mi.		RCE	Field Book	
	Cross Section (Other)	Template						V	RCE	3/mi.		RCE	Field Book	

AS-Approved Source
ASD-Approved Shop Drawing
S&T-Sampling & Testing

Cert A-Type A Certification
Cert C-Type C Certification
Cert D-Type D Certification

RCE-Resident Construction Engineer/Project Engineer
DME-District Materials Engineer
CTRL-Central Materials Office
CONTR-Contractor

IA-Independent Assurance
V-Verification

* Use Current Specification for Modified Subbase

Sampling & Testing Guide-Minimum Frequency

October 17, 2006
Supersedes October 18, 2005

MODIFIED SUBBASE
Section 2115

Matls. IM 204
Appendix C (Metric) Units

MATERIAL OR CONSTRUCTION ITEM	TESTS	METHOD OF ACCEPTANCE & RELATED IMs	QUALITY CONTROL					INDEPENDENT ASSURANCE & VERIFICATION S&T						REMARKS
			SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	S&T TYPE	SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	
SOURCE INSPECTION														
Natural Aggregate	Quality Gradation	AS 209												
Recycled Products														
Composite	Gradation	*As Per Spec.												
PCC Pavement	Gradation	*As Per Spec.												
Rap		*As Per Spec.												
GRADE INSPECTION														
Compacted Subbase	Density	*As Per Spec.						V	RCE			RCE	Field Book	
Dimensions	Thickness Width	337						V	RCE	2/2 lane km		RCE	Field Book	
	Cross Section (Primary)	Stringline						V	RCE	6/km		RCE	Field Book	
	Cross Section (Other)	Template						V	RCE	2/km		RCE	Field Book	

AS-Approved Source
ASD-Approved Shop Drawing
S&T-Sampling & Testing

Cert A-Type A Certification
Cert C-Type C Certification
Cert D-Type D Certification

RCE-Resident Construction Engineer/Project Engineer
DME-District Materials Engineer
CTRL-Central Materials Office
CONTR-Contractor

IA-Independent Assurance
V-Verification

* Use Current Specification for Modified Subbase

Sampling & Testing Guide-Minimum Frequency

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GRANULAR SUBBASE

Section 2111

Matls. IM 204
Appendix D (US) Units

MATERIAL OR CONSTRUCTION ITEM	TESTS	METHOD OF ACCEPTANCE & RELATED IMs	QUALITY CONTROL					INDEPENDENT ASSURANCE & VERIFICATION S&T						REMARKS
			SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	S&T TYPE	SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	
SOURCE INSPECTION														
Natural Aggregate (4121)	Quality Gradation	AS 209												
PCC Pavement	Gradation	209												
GRADE INSPECTION														
Compacted Subbase (2111)	Density	By Specification						V	RCE			RCE	Field Book	
Dimensions	Thickness Width	337						V	RCE	3/2 lane mi.		RCE	Field Book	
	Cross Section (Primary)	Stringline						V	RCE	10/ mi.		RCE	Field Book	
	Cross Section (Others)	Template						V	RCE	3/mi		RCE	Field Book	

AS-Approved Source	Cert A-Type A Certification	RCE-Resident Construction Engineer/Project Engineer	IA-Independent Assurance
ASD-Approved Shop Drawing	Cert C-Type C Certification	DME-District Materials Engineer	V-Verification
S&T-Sampling & Testing	Cert D-Type D Certification	CTRL-Central Materials Office	
		CONTR-Contractor	

Sampling & Testing Guide-Minimum Frequency

October 17, 2006
Supersedes October 18, 2005

GRANULAR SUBBASE
Section 2111

Matls. IM 204
Appendix D (Metric) Units

MATERIAL OR CONSTRUCTION ITEM	TESTS	METHOD OF ACCEPTANCE & RELATED IMs	QUALITY CONTROL					INDEPENDENT ASSURANCE & VERIFICATION S&T						REMARKS
			SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	S&T TYPE	SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	
SOURCE INSPECTION														
Natural Aggregate (4121)	Quality Gradation	AS 209												
PCC Pavement	Gradation	209												
GRADE INSPECTION														
Compacted Subbase (2111)	Density	By Specification						V	RCE			RCE	Field Book	
Dimensions	Thickness Width	337						V	RCE	2/2 lane km		RCE	Field Book	
	Cross Section (Primary)	Stringline						V	RCE	6/km		RCE	Field Book	
	Cross Section (Others)	Template						V	RCE	2/km		RCE	Field Book	

AS-Approved Source
ASD-Approved Shop Drawing
S&T-Sampling & Testing

Cert A-Type A Certification
Cert C-Type C Certification
Cert D-Type D Certification

RCE-Resident Construction Engineer/Project Engineer
DME-District Materials Engineer
CTRL-Central Materials Office
CONTR-Contractor

IA-Independent Assurance
V-Verification

Sampling & Testing Guide-Minimum Frequency

PORTLAND CEMENT CONCRETE PAVEMENT, PAVEMENT WIDENING, BASE WIDENING CURB & GUTTER, & PAVED SHOULDERS

October 16, 2007
Supersedes April 17, 2007

Section 2122, 2201, 2213, 2301, 2302, 2310, SS-01046

Matls. IM 204
Appendix E (US) Units

MATERIAL OR CONSTRUCTION ITEM	TESTS	METHOD OF ACCEPTANCE & RELATED IMs	QUALITY CONTROL					INDEPENDENT ASSURANCE & VERIFICATION S&T						REMARKS
			SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPT.	S&T TYPE	SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	
SOURCE INSPECTION														
Aggregates-Fine (4110)		AS 209												
Aggregate-Coarse (4115), Intermediate		AS 209												
Portland Cement (4101)	Quality	AS 401												
Fly Ash (4108)	Quality	AS 491.17												
GGBFS (Ground Granulated Blast Furnace Slag)	Quality	AS 491.14												
Curing Compounds (4105)	Lab-Tested													
Clear Curing Compounds (4105)		AB 405.07												
Air Entraining Admixture (4103)	Quality	AB 403												
Water Reducing Admix. (4103)	Quality	AB 403												
Retarding Admixture (4103)	Quality	AB 403												
Joint Sealer (4136.02)	Lab Tested	436.01, 436.02,436.03												
Backer Rod (4136.02)	Lab Tested	AB 436.04												
Mixing Water (4102)	Lab Tested							V	RCE/ CONTR	1/ source	1 pint	CTRL		Not required for potable water from municipal supply

AS-Approved Source
ASD-Approved Shop Drawing
S&T-Sampling & Testing

Cert A-Type A Certification
Cert C-Type C Certification
Cert D-Type D Certification

RCE-Resident Construction Engineer/Project Engineer
DME-District Materials Engineer
CTRL-Central Materials Office
CONTR-Contractor

IA-Independent Assurance
V-Verification
QMC-Quality Management Concrete

NOTE: RCE/CONTR indicates that the contractor shall assist in the sampling at the direction of and witnessed by the project engineer.

Sampling & Testing Guide-Minimum Frequency

PORTLAND CEMENT CONCRETE PAVEMENT, PAVEMENT WIDENING, BASE WIDENING CURB & GUTTER, & PAVED SHOULDERS

Section 2122, 2201, 2213, 2301, 2302, 2310, SS-01046

October 16, 2007
Supersedes April 17, 2007

Matls. IM 204
Appendix E (US) Units

MATERIAL OR CONSTRUCTION ITEM	TESTS	METHOD OF ACCEPTANCE & RELATED IMs	QUALITY CONTROL					INDEPENDENT ASSURANCE & VERIFICATION S&T						REMARKS
			SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	S&T TYPE	SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	
SOURCE INSPECTION														
Steel Reinforcement (4151)														
Dowels	Quality	AS 451												
Tie Bars	Quality	AS 451												
General Use	Quality	AS 451												
PLANT INSPECTION														
Aggregates-Fine (4110/4111)	Grad * QMC	302 306 336	CONTR	1/1500cy	IM 301	CONTR	800240	IA V	DME RCE CONTR	1/100,000 sy, sample 1/day, test 1st day + 2/lot	IM 301 IM 301	DME RCE/ DME		See Notes See IM 213
	Grad * Non-QMC	302 306 336	CONTR	1/day	IM 301	CONTR		IA V	DME RCE/ CONTR	1/100,000 sy, sample 1/day, test 1st day + 1/lot	IM 301 IM 301	DME RCE/ DME		
	Moist	308, 527	CONTR	1/half day	1000 gm	CONTR								Not applicable with probe
	Sp. Gr.	307	CONTR	IM 527	1000 gm	CONTR								
	Quality	AS 209												

AS-Approved Source
ASD-Approved Shop Drawing
S&T-Sampling & Testing

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Cert C-Type C Certification
Cert D-Type D Certification

RCE-Resident Construction Engineer/Project Engineer
DME-District Materials Engineer
CTRL-Central Materials Office
CONTR-Contractor

IA-Independent Assurance
V-Verification
QMC-Quality Management Concrete

* A system approach to independent assurance may be applied, at the discretion of the DME.

NOTE: When Certified Plant Inspection is not provided, the engineer is responsible for performing quality control sampling and testing.

NOTE: RCE/CONTR indicates that the contractor shall assist in the sampling at the direction of and witnessed by the project engineer.

Sampling & Testing Guide-Minimum Frequency

PORTLAND CEMENT CONCRETE PAVEMENT, PAVEMENT WIDENING, BASE WIDENING CURB & GUTTER, & PAVED SHOULDERS

October 16, 2007
Supersedes April 17, 2007

Section 2122, 2201, 2213, 2301, 2302, 2310, SS-01046

Matls. IM 204
Appendix E (US) Units

MATERIAL OR CONSTRUCTION ITEM	TESTS	METHOD OF ACCEPTANCE & RELATED IMs	QUALITY CONTROL					INDEPENDENT ASSURANCE & VERIFICATION S&T						REMARKS
			SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	S&T TYPE	SAMPLE BY	FREQ.	SAMP. SIZE	TEST BY	REPORT	
PLANT INSPECTION														
Aggregates-Coarse (4115), Intermediate	Grad * QMC	302 306 336	CONTR	QMC 1/1500 cy	IM 301	CONTR	800240	IA V	DME RCE/ CONTR	1/100,000 sy Sample 1/day,test 1st day+2/lot	IM 301 IM 301	DME RCE/ DME		See Notes
	Grad * Non-QMC	302 306 336	CONTR	1/day	IM 301	CONTR		IA V	DME RCE/ CONTR	1/100,000 sy, sample 1/day, test 1st day + 1/lot	IM 301 IM 301	DME RCE/ DME		
	Moist	308	CONTR	1/half day	IM 301	CONTR								
	Sp. Gr.	307	CONTR	IM 527	IM 301	CONTR								
	Quality	AS 209						V	DME	1/100,000 sy	50 lb	CTRL		
Portland Cement (4101)	Quality	AS Cert D		Each Load				V	DME	1/100,000 sy	15 lb	CTRL		
	Cement Yield		CONTR	1/10,000 cy		CONTR	820912							
Fly Ash	Quality	AS Cert D		Each Load			800240	V	DME	1/100,000 sy	15 lb	CTRL		
GGBFS(Ground Granulated Blast Furnace Slag)	Quality	AS Cert		Each Load				V	DME	1/100,000 sy	15 lb	CTRL		
Air Admixture	Quality	AS 403						V	DME	1/batch	1 pint	CTRL		Sample batches not previously reported or as required by DME
Water Reducer	Quality	AS 403						V	DME	1/batch	1 pint	CTRL		
Retarding Admixture	Quality	AS 403						V	DME	1/batch	1 pint	CTRL		

AS-Approved Source
ASD-Approved Shop Drawing
S&T-Sampling & Testing

Cert A-Type A Certification
Cert C-Type C Certification
Cert D-Type D Certification

RCE-Resident Construction Engineer/Project Engineer
DME-District Materials Engineer
CTRL-Central Materials Office
CONTR-Contractor

IA-Independent Assurance
V-Verification
QMC-Quality Management Concrete

* A system approach to independent assurance may be applied, at the discretion of the DME.

NOTE: When Certified Plant Inspection is not provided, the engineer is responsible for performing quality control sampling and testing.

NOTE: Quality samples not required when mix quantity is less than 2000 sq. yds., except for curing compound.

NOTE: RCE/CONTR indicates that the contractor shall assist in the sampling at the direction of and witnessed by the project engineer.

Sampling & Testing Guide-Minimum Frequency

PORTLAND CEMENT CONCRETE PAVEMENT, PAVEMENT WIDENING, BASE WIDENING CURB & GUTTER, & PAVED SHOULDERS

Section 2122, 2201, 2213, 2301, 2302, 2310, SS-01046

October 16, 2007
Supersedes April 17, 2007

Matls. IM 204
Appendix E (US) Units

MATERIAL OR CONSTRUCTION ITEM	TESTS	METHOD OF ACCEPTANCE & RELATED IMs	QUALITY CONTROL					INDEPENDENT ASSURANCE & VERIFICATION S&T						REMARKS
			SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPT.	S&T TYPE	SAMP. BY	FREQ.	SAMPLE SIZE	TEST BY	REPT.	
GRADE INSPECTION														
Chloride Solution	Concentration	373	RCE	1/day										
Steel Reinforcement:														
Dowels	Quality	AS 451.03B						V	DME	1/District/Yr	2 ft	CTRL		
Dowel Basket Assembly	Quality	AS 451 Cert D 451.03B												
Tie Bars	Quality	AS 451						V	DME	1/District/Yr	2 ft	CTRL		
General Use	Quality	AS 451						V	DME	1/District/Yr	48 in	CTRL		
Curing Compound	Quality	Tested 4105						V	DME	1/batch	1/qt	CTRL		Sample batches not previously reported or as required by DME
Plastic Concrete	Air	318 327	QMC CONTR	QMC only 2301.04C 1/350 cy		QMC CONTR	E115	IA V	DME RCE	1/100,000 sy 2301.04C 1/700 cy, 1/100 cy for transit mixer		DME RCE		Min. 1 test/pour
	Slump	317						V	RCE	1/700 cy, min 1/pour		RCE		For hand finish or fixed form only
	Grade Yield		RCE	1/1000 cy		RCE								
	Beams**	316, 327, 328	RCE	2/day		RCE	E115							
Hardened Concrete	Thickness*	346, 347						IA V	DME RCE/ CONTR	1/2000 sy	10%	DME RCE		
	Smoothness	341 Cert. Test Rept.	CONTR		100%	CONTR		V	DME		10%	DME		

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S&T-Sampling & Testing
Cert A-Type A Certification
Cert C-Type C Certification
Cert D-Type D Certification
RCE-Resident Construction Engineer/Project Engineer
DME-District Materials Engineer
CTRL-Central Materials Office
CONTR-Contractor
IA-Independent Assurance
V-Verification
QMC-Quality Management Concrete

*IA thickness cores sent to Central Lab for additional project information testing (Interstate and Primary only.)

**None required when maturity is used. Quality samples not required when mix quantity is less than 2000 sq. yds., except for curing compound.

NOTE: RCE/CONTR indicates that the contractor shall assist in the sampling at the direction of and witnessed by the project engineer. **NOTE:** Form #E115 available from the Office of Construction.

Sampling & Testing Guide-Minimum Frequency

PORTLAND CEMENT CONCRETE PAVEMENT, PAVEMENT WIDENING, BASE WIDENING CURB & GUTTER, & PAVED SHOULDERS

Section 2122, 2201, 2213, 2301, 2302, 2310, SS-01046

October 16, 2007
Supersedes April 17, 2007

Matls. IM 204
Appendix E (Metric) Units

MATERIAL OR CONSTRUCTION ITEM	TESTS	METHOD OF ACCEPTANCE & RELATED IMs	QUALITY CONTROL					INDEPENDENT ASSURANCE & VERIFICATION S&T						REMARKS
			SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	S&T TYPE	SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	
SOURCE INSPECTION														
Aggregates-Fine (4110)		AS 209												
Aggregate-Coarse (4115), Intermediate		AS 209												
Portland Cement (4101)	Quality	AS 401												
Fly Ash (4108)	Quality	AS 491.17												
GGBFS (Ground Granulated Blast Furnace Slag)	Quality	AS 491.14												
Curing Compounds (4105)	Lab-Tested													
Clear Curing Compounds (4105)		AB 405.07												
Air Entraining Admixture (4103)	Quality	AB 403												
Water Reducing Admix. (4103)	Quality	AB 403												
Retarding Admixture (4103)	Quality	AB 403												
Joint Sealer (4136.02)	Lab Tested	436.01, 436.02,436.03												
Backer Rod (4136.02)	Lab Tested	AB 436.04												
Mixing Water (4102)	Lab Tested							V	RCE/ CONTR	1/source	0.5 L	CTRL		Not required for potable water from municipal supply

AS-Approved Source
ASD-Approved Shop Drawing
S&T-Sampling & Testing

Cert A-Type A Certification
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Cert D-Type D Certification

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CONTR-Contractor

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V-Verification
QMC-Quality Management Concrete

NOTE: RCE/CONTR indicates that the contractor shall assist in the sampling at the direction of and witnessed by the project engineer.

Sampling & Testing Guide-Minimum Frequency

PORTLAND CEMENT CONCRETE PAVEMENT, PAVEMENT WIDENING, BASE WIDENING CURB & GUTTER, & PAVED SHOULDERS

October 16, 2007
Supersedes April 17, 2007

Section 2122, 2201, 2213, 2301, 2302, 2310, SS-01046

Matls. IM 204
Appendix E (Metric) Units

MATERIAL OR CONSTRUCTION ITEM	TESTS	METHOD OF ACCEPTANCE & RELATED IMs	QUALITY CONTROL					INDEPENDENT ASSURANCE & VERIFICATION S&T						REMARKS
			SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	S&T TYPE	SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	
SOURCE INSPECTION														
Steel Reinforcement (4151)														
Dowels	Quality	AS 451												
Tie Bars	Quality	AS 451												
General Use	Quality	AS 451												
PLANT INSPECTION														
Aggregates-Fine (4110/4111)	Grad * QMC	302 306 336	CONTR	1/1200 m^3	IM 301	CONTR	800240	IA V	DME RCE/ CONTR	1/100,000 m^2, sample 1/day, test 1st day + 2/lot	IM 301 IM 301	DME RCE/ DME		See Notes See IM 213
	Grad * Non-QMC	302 306 336	CONTR	1/day	IM 301	CONTR		IA V	DME RCE/ CONTR	1/100,000 m^2 Sample 1/day, test 1st day+1/lot	IM 301 IM 301	DME RCE/ DME		
	Moist	308, 527	CONTR	1/half day	1000 gm	CONTR								Not applicable with probe
	Sp. Gr.	307	CONTR	IM 527	1000 gm	CONTR								
	Quality	AS 209												

AS-Approved Source
ASD-Approved Shop Drawing
S&T-Sampling & Testing

Cert A-Type A Certification
Cert C-Type C Certification
Cert D-Type D Certification

RCE-Resident Construction Engineer/Project Engineer
DME-District Materials Engineer
CTRL-Central Materials Office
CONTR-Contractor

IA-Independent Assurance
V-Verification
QMC-Quality Management Concrete

* A system approach to independent assurance may be applied, at the discretion of the DME.

NOTE: When Certified Plant Inspection is not provided, the engineer is responsible for performing quality control sampling and testing.

NOTE: RCE/CONTR indicates that the contractor shall assist in the sampling at the direction of and witnessed by the project engineer.

Sampling & Testing Guide-Minimum Frequency

PORTLAND CEMENT CONCRETE PAVEMENT, PAVEMENT WIDENING, BASE WIDENING CURB & GUTTER, & PAVED SHOULDERS

October 16, 2007
Supersedes April 17, 2007

Section 2122, 2201, 2213, 2301, 2302, 2310, SS-01046

Matls. IM 204
Appendix E (Metric) Units

MATERIAL OR CONSTRUCTION ITEM	TESTS	METHOD OF ACCEPTANCE & RELATED IMs	QUALITY CONTROL					INDEPENDENT ASSURANCE & VERIFICATION S&T						REMARKS
			SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	S&T TYPE	SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	
PLANT INSPECTION														
Aggregates-Coarse (4115), Intermediate	Grad * QMC	302 306 336	CONTR	1/1200m^3	IM 301	CONTR	800240	IA V	DME RCE/ CONTR	1/100,000 m^2 Sample 1/day,test 1st day+2/lot	IM 301 IM 301	DME RCE/ DME		See Notes
	Grad * Non-QMC	302 306 336	CONTR	1/day	IM 301	CONTR		IA V	DME RCE/ CONTR	1/100,000 m^2 Sample 1/day, test 1st day+1/lot	IM 301 IM 301	DME RCE/ DME		
	Moist	308	CONTR	1/half day	IM 301	CONTR								
	Sp. Gr.	307	CONTR	IM 527	IM 301	CONTR								
	Quality	AS 209						V	DME	1/100,000 m^2	22kg	CTRL		
Portland Cement (4101)	Quality	AS Cert D		Each Load				V	DME	1/100,000 m^2	7 kg	CTRL		
	Cement Yield		CONTR	1/7500m^3		CONTR	820912							
Fly Ash	Quality	AS Cert D		Each load			800240	V	DME	1/100,000 m^2	7 kg	CTRL		
GGBFS(Ground Granulated Blast Furnace Slag)	Quality	AS Cert		Each load				V	DME	1/100,000 m^2	7 kg	CTRL		
Air Admixture	Quality	AS 403						V	DME	1/batch	0.5 L	CTRL		Sample batches not previously reported or as required by DME
Water Reducer	Quality	AS 403						V	DME	1/batch	0.5 L	CTRL		
Retarding Admixture	Quality	AS 403						V	DME	1/batch	0.5 L	CTRL		

AS-Approved Source
ASD-Approved Shop Drawing
S&T-Sampling & Testing

Cert A-Type A Certification
Cert C-Type C Certification
Cert D-Type D Certification

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V-Verification
QMC-Quality Management Concrete

* A system approach to independent assurance may be applied, at the discretion of the DME.

NOTE: When Certified Plant Inspection is not provided, the engineer is responsible for performing quality control sampling and testing.

NOTE: Quality samples not required when mix quantity is less than 2000 m^2, except for curing compound.

NOTE: RCE/CONTR indicates that the contractor shall assist in the sampling at the direction of and witnessed by the project engineer.

Sampling & Testing Guide-Minimum Frequency

PORTLAND CEMENT CONCRETE PAVEMENT, PAVEMENT WIDENING, BASE WIDENING CURB & GUTTER, & PAVED SHOULDERS

Section 2122, 2201, 2213, 2301, 2302, 2310, SS-01046

October 16, 2007
Supersedes April 17, 2007

Matls. IM 204
Appendix E (Metric) Units

MATERIAL OR CONSTRUCTION ITEM	TESTS	METHOD OF ACCEPTANCE & RELATED IMs	QUALITY CONTROL					INDEPENDENT ASSURANCE & VERIFICATION S&T						REMARKS
			SAMPLE BY	FREQ.	SAMP. SIZE	TEST BY	REPT.	S&T TYPE	SAMP. BY	FREQ.	SAMP. SIZE	TEST BY	REPT.	
GRADE INSPECTION														
Chloride Solution	Concentration	373	RCE	1/day										
Steel Reinforcement:														
Dowels	Quality	AS 451.03B						V	DME	1/District/Yr	0.5 m	CTRL		
Dowel Basket Assembly	Quality	AS 451 Cert D 451.03B												
Tie Bars	Quality	AS 451						V	DME	1/District/Yr	0.5 m	CTRL		
General Use	Quality	AS 451						V	DME	1/District/Yr	1 m	CTRL		
Curing Compound	Quality	Tested 4105						V	DME	1/batch	1/L	CTRL		Sample batches not previously reported or as required by DME
Plastic Concrete	Air	318 327	QMC CONTR	QMC only 2301.04C 1/275 m^3		QMC CONTR	E115	IA V	DME RCE	1/100,000 m^2 2301.04C 1/550m^3 1/75 m^3 for transit mixer		DME RCE		Min. 1 test/pour
	Slump	317						V	RCE	1/550 m^3, min. 1/pour		RCE		For hand finish or fixed form only
	Grade Yield		RCE	1/750 m^3		RCE								
	Beams**	316, 327, 328	RCE	2/day		RCE	E115							
Hardened Concrete	Thickness*	346, 347						IA V	DME RCE/ CONTR	1/2000 m^2	10%	DME RCE		
	Smoothness	341Cert. Test Report	CONTR		100%	CONTR		V	DME		10%	DME		

AS-Approved Source
ASD-Approved Shop Drawing
S&T-Sampling & Testing

Cert A-Type A Certification
Cert C-Type C Certification
Cert D-Type D Certification

RCE-Resident Construction Engineer/Project Engineer
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IA-Independent Assurance
V-Verification

QMC-Quality Management Concrete

*IA thickness cores sent to Central Lab for additional project information testing (Interstate and Primary only.)

PORTLAND CEMENT CONCRETE PAVEMENT, PAVEMENT WIDENING, BASE WIDENING CURB & GUTTER, & PAVED SHOULDERS

Section 2122, 2201, 2213, 2301, 2302, 2310, SS-01046

**None required when maturity is used. Quality samples not required when mix quantity is less than 2000 m², except for curing compound.

NOTE: RCE/CONTR indicates that the contractor shall assist in the sampling at the direction of and witnessed by the project engineer.

NOTE: Form #E115 available from the Office of Construction.

HOT MIX ASPHALT

Section 2303, 2213, & 2114

MATERIAL OR CONSTRUCTION ITEM	TESTS	METHOD OF ACCEPTANCE & RELATED IMs	QUALITY CONTROL					INDEPENDENT ASSURANCE, & VERIFICATION S&T						REMARKS
			SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	S&T TYPE	SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	
SOURCE INSPECTION														
Aggregates-Coarse (4127)		AS 209												
Aggregates-Fine (4127)		AS 209												
Hydrated Lime (4126/4127)		AS 491.04												
Asphalt Binder		AS 437												
Emulsions & Cutbacks		AS 437												
Release Agent		AB 491.15												
PLANT INSPECTION														
Aggregates (2303)	Quality							V	DME	1/20,000 Ton	50 lb.	CTRL		
Combined Aggregate (4126, 4127)	Gradation		RCE/ CONTR	1/lot	IM 301	CONTR		V IA	RCE/ CONTR	Sample 1/day, Test 1st day + 20% Systems Approach*	IM 301	DME/ RCE	IM 216 IM 216	
	Moisture		CONTR	1 / half day	1000 gm	CONTR								Dryer Drum Plants Only

AS-Approved Source
ASD-Approved Shop Drawing
S&T-Sampling & Testing

Cert A-Type A Certification
Cert C-Type C Certification
Cert D-Type D Certification

RCE-Resident Construction Engineer/Project Engineer
DME-District Materials Engineer
CTRL-Central Materials Office
CONTR-Contractor

IA-Independent Assurance
V-Verification

*A project approach may be applied at the discretion of the DME at the frequency 1/project.

NOTE: RCE/CONTR indicates that the Contractor shall assist in the sampling at the direction of and witnessed by the Project Engineer.

Sampling & Testing Guide-Minimum Frequency

April 17, 2007
Supersedes October 17, 2006

HOT MIX ASPHALT
Section 2303, 2213, & 2114

Matls. IM 204
Appendix F (US) Units

MATERIAL OR CONSTRUCTION ITEM	TESTS	METHOD OF ACCEPTANCE & RELATED IMs	QUALITY CONTROL					INDEPENDENT ASSURANCE, & VERIFICATION S&T						REMARKS
			SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	S&T TYPE	SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	
PLANT INSPECTION														
Mineral Filler								V	DME	1/project	5 kg	DME	821278	
Asphalt Binder	DSR Quality	AS Cert D						V V IA	RCE/ CONTR DME	Sample 1/day Test 1st 3days + 1/week 1/20,000 T of Mix Systems Approach	4 oz tin 1 qt	DME CTRL		Log all shipments
Cutback		AS 329												Log all shipments
Emulsion	Residue	AS 360						V	RCE	1/project	1 qt	DME		Plastic bottle required
GRADE INSPECTION														
Uncompacted Mixture:	Lab Density & Lab Voids	321, 350 325G	RCE/ CONTR	As per 2303	30 lb	CONTR		V IA	RCE/ CONTR	As per 2303 Test 1/day Systems Approach	30 lb	DME		May be adjusted by DME as per 2303
Compacted Mixture	Density, Thickness & Voids	320, 321 337	RCE/ CONTR	Lot	7/lot	RCE		IA	DME	1 lot/project*		DME		
	Smoothness	341	CONTR	100%	100%	CONTR		V	DME	10%		DME		

AS-Approved Source
ASD-Approved Shop Drawing
S&T-Sampling & Testing

Cert A-Type A Certification
Cert C-Type C Certification
Cert D-Type D Certification

RCE-Resident Construction Engineer/Project Engineer
DME-District Materials Engineer
CTRL-Central Materials Office
CONTR-Contractor

IA-Independent Assurance
V-Verification

* A system approach may be applied at the discretion of the DME.

NOTE: Verification not required under 2000 tons of mix.

NOTE: RCE/CONTR indicates that the Contractor shall assist in the sampling at the direction of and witnessed by the Project Engineer.

Sampling & Testing Guide-Minimum Frequency

April 17, 2007
Supersedes October 17, 2006

HOT MIX ASPHALT

Section 2303, 2113, & 2114

Matls. IM 204
Appendix F (Metric) Units

MATERIAL OR CONSTRUCTION ITEM	TESTS	METHOD OF ACCEPTANCE & RELATED IMs	QUALITY CONTROL					INDEPENDENT ASSURANCE, & VERIFICATION S&T						REMARKS
			SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	S&T TYPE	SAMPLE BY	FREQ. Note 1	SAMPLE SIZE	TEST BY	REPORT	
SOURCE INSPECTION														
Aggregates-Coarse (4127)		AS 209												
Aggregates-Fine (4127)		AS 209												
Hydrated Lime (4126/4127)		AS 491.04												
Asphalt Binder		AS 437												
Emulsions & Cutbacks		AS 437												
Release Agent		AS 491.15												
PLANT INSPECTION														
Aggregates (2303)	Quality							V	DME	1/20,000 Mg	22 kg	CTRL		
Combined Aggregate (4126, 4127)	Gradation		RCE/ CONTR	1/lot	IM 301	CONTR		V IA	RCE/ CONTR	Sample 1/day, Test 1st day + 20% Systems Approach*	IM 301	DME/RCE DME	IM 216 IM 216	
	Moisture		CONTR	1/halfday	1000 gm	CONTR								Dryer Drum Plants Only

AS-Approved Source
ASD-Approved Shop Drawing
S&T-Sampling & Testing

Cert A-Type A Certification
Cert C-Type C Certification
Cert D-Type D Certification

RCE-Resident Construction Engineer/Project Engineer
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CONTR-Contractor

IA-Independent Assurance
V-Verification

*A project approach may be applied at the discretion of the DME at the frequency 1/project.

NOTE: RCE/CONTR indicates that the contractor shall assist in the sampling at the direction of and witnessed by the project engineer.

HOT MIX ASPHALT

Section 2303, 2113, & 2114

MATERIAL OR CONSTRUCTION ITEM	TESTS	METHOD OF ACCEPTANCE & RELATED IMs	QUALITY CONTROL					INDEPENDENT ASSURANCE, & VERIFICATION S&T						REMARKS
			SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	S&T TYPE	SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	
PLANT INSPECTION														
Mineral Filler								V	DME	1/project	5 kg	DME	821278	
Asphalt Binder	DSR	AS Cert D						V	RCE/ CONTR	Sample 1/day, Test 1st day + 20%	120 ml	DME		Log all shipments
	Quality							V IA	DME	Systems Approach	1 L	CTRL		
Cutback	Quality Viscosity	AS 329												Log all shipments
Emulsion	Residue	AS 360						V	RCE	1/project	1 L	DME		Plastic bottle required
GRADE INSPECTION														
Uncompacted Mixture:	Lab Density & Lab Voids	321, 350 325G	RCE/ CONTR	As per 2303	14 kg	CONTR		V IA	RCE/ CONTR	As per 2303, Test 1/day Systems Approach	14 kg	DME		May be adjusted by DME as per 2303
Compacted Mixture	Density Thickness Voids	320, 321 337	RCE/ CONTR	Lot	7/lot	RCE		IA	DME	1/lot/project		DME		
	Smoothness	341	CONTR	100%	100%	CONTR		V	DME	10%		DME		

AS-Approved Source
ASD-Approved Shop Drawing
S&T-Sampling & Testing

Cert A-Type A Certification
Cert C-Type C Certification
Cert D-Type D Certification

RCE-Resident Construction Engineer/Project Engineer
DME-District Materials Engineer
CTRL-Central Materials Office
CONTR-Contractor

IA-Independent Assurance
V-Verification

* A system approach may be applied at the discretion of the DME.

<u>NOTE</u>: Verification not required under 2000 Mg of mix.

<u>NOTE</u>: RCE/CONTR indicates that the contractor shall assist in the sampling at the direction of and witnessed by the project engineer.

Sampling & Testing Guide-Minimum Frequency

STRUCTURAL CONCRETE, REINFORCEMENT, FOUNDATIONS & SUBSTRUCTURES, CONCRETE STRUCTURES, CONCRETE FLOORS, & CONCRETE BOX, ARCH & CIRCULAR CULVERTS

Sections 2403, 2404, 2405, 2406, 2412, & 2415

October 16, 2007
Supersedes April 17, 2007

Matls. IM 204
Appendix H (US) Units

MATERIAL OR CONSTRUCTION ITEM	TESTS	METHOD OF ACCEPTANCE & RELATED IMs	QUALITY CONTROL					INDEPENDENT ASSURANCE & VERIFICATION S&T						REMARKS
			SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	S&T TYPE	SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	
SOURCE INSPECTION														
Aggregate-Fine (4110)		AS 209												
Aggregate-Coarse (4115)		AS 209												
Granular Backfill (4133)		AS 209												
Portland Cement (4101)	Quality	AS 401												
Fly Ash (4108)	Quality	AS 491.17												
Mixing Water (4102)	Quality							V	RCE	1/project	1 L	CTRL	731	Not required for potable water from Municipal Supply
GGBFS (Ground Granulated Blast Furnace Slag)	Quality	AS 491.14												
Air Entraining Admixture	Quality	AS 403												
Retarding Admixture	Quality	AS 403												
Water reducing Admixture	Quality	AS 403												Sample batches not previously reported or as required by DME
Curing Compound, White (4105)	Lab Tested	AS 405						V	DME	1/batch	1qt	CTRL		
Curing Compound, Clear (4105)		AS 405.07												

AS-Approved Source
ASD-Approved Shop Drawing
S&T-Sampling & Testing

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Cert C-Type C Certification
Cert D-Type D Certification

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V-Verification

NOTE: RCE/CONTR indicates that the Contractor shall assist in the sampling at the direction of and witnessed by the Project Engineer.

STRUCTURAL CONCRETE, REINFORCEMENT, FOUNDATIONS & SUBSTRUCTURES, CONCRETE STRUCTURES, CONCRETE FLOORS, & CONCRETE BOX, ARCH & CIRCULAR CULVERTS

Sections 2403, 2404, 2405, 2406, 2412, & 2415

MATERIAL OR CONSTRUCTION ITEM	TESTS	METHOD OF ACCEPTANCE & RELATED IMS	QUALITY CONTROL					INDEPENDENT ASSURANCE & VERIFICATION S&T						REMARKS
			SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	S&T TYPE	SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	
SOURCE INSPECTION														
Pre-formed Joint Sealer (4136)	Lab-Tested	AS 436.02 436.05												
Reinforcing Steel Bars (4151)	Quality	AS 451												
Steel Pile (4167)	Quality	467												
Concrete Pile (4166)	Quality	AS 570												
Timber Pile (4165)	Quality	Cert A 462 AS												
Timber (4162) & Lumber (4163		Treated-Cert A 462 AS												
Concrete Anchors	Quality	AS 453.09												
Epoxy Grout	Quality	AS 491.11												
Concrete Sealer	Quality	AS 491.12												
Subdrain Pipe (4143)	Quality	AS 443, 448												
Neoprene Bearing Pads (4195)		AS 495.03												
Bronze Bearing Plates (4190.03)		AS D/Cert A												

AS-Approved Source
ASD-Approved Shop Drawing
S&T-Sampling & Testing
Cert A-Type A Certification
Cert C-Type C Certification
Cert D-Type D Certification
RCE-Resident Construction Engineer/Project Engineer
DME-District Materials Engineer
CTRL-Central Materials Office
CONTR-Contractor
IA-Independent Assurance
V-Verification

NOTE: RCE/CONTR indicates that the Contractor shall assist in the sampling at the direction of and witnessed by the Project Engineer.

Sampling & Testing Guide-Minimum Frequency

STRUCTURAL CONCRETE, REINFORCEMENT, FOUNDATIONS & SUBSTRUCTURES, CONCRETE STRUCTURES, CONCRETE FLOORS, & CONCRETE BOX, ARCH & CIRCULAR CULVERTS

Sections 2403, 2404, 2405, 2406, 2412, & 2415

October 16, 2007
Supersedes April 17, 2007

Matls. IM 204
Appendix H (US) Units

MATERIAL OR CONSTRUCTION ITEM	TESTS	METHOD OF ACCEPTANCE & RELATED IMs	QUALITY CONTROL					INDEPENDENT ASSURANCE & VERIFICATION S&T						REMARKS
			SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	S&T TYPE	SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	
SOURCE INSPECTION														
Steel Masonry Plate (4152)		ASD/Cert A												
Precast Units (2407)	Quality	AS 570												
Anchor Bolts (lighting, signing, handrail) (4153)	Lab Tested	ASD												
Structural Steel (4152)	Quality	Cert A												Monitor Sample According to plans or other instructions
Aluminum Bridge Rail & Anchor Assembly		ASD												
Conduit (Electrical) (4185.10)) Steel		AS												
Conduit (Plastic) (4185.10)	Lab Tested							V	DME	1/size	4'	CTRL		
Bentonite		Visual												
Flowable Mortar	Lab Tested	Approved Trial Mix 525, 375												Tested by DME

AS-Approved Source
ASD-Approved Shop Drawing
S&T-Sampling & Testing

Cert A-Type A Certification
Cert C-Type C Certification
Cert D-Type D Certification

RCE-Resident Construction Engineer/Project Engineer
DME-District Materials Engineer
CTRL-Central Materials Office
CONTR-Contractor

IA-Independent Assurance
V-Verification

NOTE: RCE/CONTR indicates that the Contractor shall assist in the sampling at the direction of and witnessed by the Project Engineer.

STRUCTURAL CONCRETE, REINFORCEMENT, FOUNDATIONS & SUBSTRUCTURES, CONCRETE STRUCTURES, CONCRETE FLOORS, & CONCRETE BOX, ARCH & CIRCULAR CULVERTS

Sections 2403, 2404, 2405, 2406, 2412, & 2415

MATERIAL OR CONSTRUCTION ITEM	TESTS	METHOD OF ACCEPTANCE & RELATED IMs	QUALITY CONTROL					INDEPENDENT ASSURANCE & VERIFICATION S&T						REMARKS
			SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	S&T TYPE	SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	
PLANT INSPECTION														
Aggregate- Fine (4110)	Gradation Deck	302, 306 336	CONTR	IM 528	IM 301	CONTR	800240	IA V	DME RCE/ CONTR	1/1000 cy Sample & Test 1/deck/wk	IM 301 IM 301	DME RCE		May Use System App.
	Gradation All other		CONTR	IM 528	IM 301	CONTR		IA V	DME RCE/ CONTR	1-1000 cy Sample 1/wk Test 1st day +20%	IM 301 IM 301	RCE		May Use System App.
	Moisture	308, 528	CONTR	1/lot	1000 gm	CONTR								See IM 528 if Moisture Probe is used
	Sp. Gr.	307	CONTR	IM 528	1000 gm	CONTR								
	Quality	AS 209												
Aggregate- Coarse (4115)	Gradation Deck	302, 306 336	CONTR	IM 528	IM 301	CONTR		IA V	DME RCE/ CONTR	1/1000 cy Sample & Test 1/deck/wk	IM 301 IM 301	DME RCE		May Use System App.
	Gradation All other		CONTR	IM 528	IM 301	CONTR		IA V	DME RCE/ CONTR	1/1000 cy Sample 1/wk Test 1st day +20%	IM 301 IM 301	DME RCE		May Use System App.
	Moisture	308, 528	CONTR	1/lot	2000gm	CONTR								
	Sp. Gr.	307	CONTR	IM 528	2000gm	CONTR								
	Quality	AS 209						V	DME	1/1000 cy	50 lb	CTR L		(1)
Portland Cement	w/c ratio	528	CONTR	1/pour		CONTR								
	Quality	AS Cert D						V	DME	1/1000 cy	15 lb	CTR L		(1)

AS-Approved Source	Cert A-Type A Certification	RCE-Resident Construction Engineer/Project Engineer	IA-Independent Assurance
ASD-Approved Shop Drawing	Cert C-Type C Certification	DME-District Materials Engineer	V-Verification
S&T-Sampling & Testing	Cert D-Type D Certification	CTRL-Central Materials Office	
		CONTR-Contractor	

(1) These verification samples for concrete materials not required when mix quantity is less than 50 cu. yd.

NOTE: RCE/CONTR indicates that the Contractor shall assist in the sampling at the direction of and witnessed by the Project Engineer.

Sampling & Testing Guide-Minimum Frequency

STRUCTURAL CONCRETE, REINFORCEMENT, FOUNDATIONS & SUBSTRUCTURES, CONCRETE STRUCTURES, CONCRETE FLOORS, & CONCRETE BOX, ARCH & CIRCULAR CULVERTS

Sections 2403, 2404, 2405, 2406, 2412, & 2415

October 16, 2007
Supersedes April 17, 2007

Matls. IM 204
Appendix H (US) Units

MATERIAL OR CONSTRUCTION ITEM	TESTS	METHOD OF ACCEPTANCE & RELATED IMs	QUALITY CONTROL					INDEPENDENT ASSURANCE & VERIFICATION S&T						REMARKS
			SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	S&T TYPE	SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	
PLANT INSPECTION														
Fly Ash	Quality	AS Cert D		Each Load			800240							
GGBFS(Ground Granulated Blast Furnace Slag)	Quality	AS Cert D		Each Load										
Air-Entraining Admixture (4103)		AS 403						V	RCE	1/batch	0.5 L	CTRL		(1) Sample lots not previously reported or as required by DME
Retarding Admixture		AS 403						V	RCE	1/batch	0.5 L	CTRL		
Water Reducing Admixture (4103)		AS 403						V	RCE	1/batch	0.5 L	CTRL		
GRADE INSPECTION														
Plastic Concrete	Air Content	316, 327					E145*	IA V	DME RCE	1/1000 cy 1/30 cy		DME RCE		DME may adjust
	Slump	317, 327						IA V	DME RCE	1/1000 cy 1/30 cy		Witness Only RCE		DME may adjust
	Beams	316, 327, 328							RCE	2/placement		RCE		If required per 2403.18 and 2403.19
	Cylinders								DME	3/project		DME		Primary Projects Only (Information only)

AS-Approved Source
ASD-Approved Shop Drawing
S&T-Sampling & Testing

Cert A-Type A Certification
Cert C-Type C Certification
Cert D-Type D Certification

RCE-Resident Construction Engineer/Project Engineer
DME-District Materials Engineer
CTRL-Central Materials Office
CONTR-Contractor

IA-Independent Assurance
V-Verification

(1) These verification samples for concrete materials not required when mix quantity is less than 50 cu. yd.

NOTE: RCE/CONTR indicates that the Contractor shall assist in the sampling at the direction of and witnessed by the Project Engineer.

*Available from the Office of Construction.

STRUCTURAL CONCRETE, REINFORCEMENT, FOUNDATIONS & SUBSTRUCTURES, CONCRETE STRUCTURES, CONCRETE FLOORS, & CONCRETE BOX, ARCH & CIRCULAR CULVERTS

Sections 2403, 2404, 2405, 2406, 2412, & 2415

MATERIAL OR CONSTRUCTION ITEM	TESTS	METHOD OF ACCEPTANCE & RELATED IMs	QUALITY CONTROL					INDEPENDENT ASSURANCE & VERIFICATION S&T						REMARKS
			SAMPLE BY	FREQ.	SAMPLE SIZE	TES BY	REPORT	S&T TYPE	SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	
GRADE INSPECTION														
Reinforcing Steel (4151)	Quality	AS Cert A		Each Shipment			Field Book	V	DME	IM 451	6 ft	CTRL		
Reinforcing Steel Epoxy Coated (4151)	Quality	AS Cert A		Each Shipment			Field Book	V	DME	1 bar	6 ft	CTRL		Will be acceptance tested for coating
Steel Pile (4167)	Quality	AS Cert A		Each Heat			Field Book		DME	IM 467		CTRL		
Timber Pile (4165)	Quality	AS 462 Cert A						V	DME	IM 467		CTRL		No grade requirement Charge numbers on butt end.
Anchor Bolts (lighting, signing, handrail)	Lab Tested	ASD						V	DME	1/project	1 bolt w/nut & washer	CTRL		Sample only if not source inspected
Steel Masonry Plates (4152)		ASD Cert A		Each Shipment			Field Book							Approved by Materials Department
Bronze Bearing Plates (4190.03)	Lab Tested							V	DME	1/project	1 only	CTRL		Sample only if not source inspected
Neoprene Bearing Pads (4195)		AS 495.03		Each Shipment			820905							
Alum. Bridge Rail & Anchor Assembly		ASD		Each Shipment			Field Book							Approved By Materials Dept.
Drains (Std Steel Pipe)(as per plan)	Dimensions Galvanized	ASD Visual 332						V	DME	1/project		DME		

AS-Approved Source
ASD-Approved Shop Drawing
S&T-Sampling & Testing

Cert A-Type A Certification
Cert C-Type C Certification
Cert D-Type D Certification

RCE-Resident Construction Engineer/Project Engineer
DME-District Materials Engineer
CTRL-Central Materials Office
CONTR-Contractor

IA-Independent Assurance
V-Verification

NOTE: RCE/CONTR indicates that the Contractor shall assist in the sampling at the direction of and witnessed by the Project Engineer.

Sampling & Testing Guide-Minimum Frequency

STRUCTURAL CONCRETE, REINFORCEMENT, FOUNDATIONS & SUBSTRUCTURES, CONCRETE STRUCTURES, CONCRETE FLOORS, & CONCRETE BOX, ARCH & CIRCULAR CULVERTS

Sections 2403, 2404, 2405, 2406, 2412, & 2415

October 16, 2007
Supersedes April 17, 2007

Matls. IM 204
Appendix H (US) Units

MATERIAL OR CONSTRUCTION ITEM	TESTS	METHOD OF ACCEPTANCE & RELATED IMs	QUALITY CONTROL					INDEPENDENT ASSURANCE & VERIFICATION S&T						REMARKS
			SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	S&T TYPE	SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	
GRADE INSPECTION														
Timber (4162) & Lumber (4163)	Quality	AS 462 Treated-Cert A												
Subdrain Pipe (4143)	Quality	AS Cert D 443, 448		Each Shipment										
Flowable Mortar (2506)	Flow Test	375	RCE	As needed for Project Control		RCE	830211							Mix Design approval by DME
Bentonite	Flow Test	Visual 375				RCE								
Smoothness (2317)	Profilometer	Cert. Test Report 341	CONTR	Each Project	Each Wheelpath	CONTR	821301	V		10%	DME			

AS-Approved Source
ASD-Approved Shop Drawing
S&T-Sampling & Testing

Cert A-Type A Certification
Cert C-Type C Certification
Cert D-Type D Certification

RCE-Resident Construction Engineer/Project Engineer
DME-District Materials Engineer
CTRL-Central Materials Office
CONTR-Contractor

IA-Independent Assurance
V-Verification

NOTE: RCE/CONTR indicates that the Contractor shall assist in the sampling at the direction of and witnessed by the Project Engineer.

Sampling & Testing Guide-Minimum Frequency

STRUCTURAL CONCRETE, REINFORCEMENT, FOUNDATIONS & SUBSTRUCTURES, CONCRETE STRUCTURES, CONCRETE FLOORS, & CONCRETE BOX, ARCH & CIRCULAR CULVERTS

Sections 2403, 2404, 2405, 2406, 2412, & 2415

October 16, 2007
Supersedes April 17, 2007

Matls. IM 204
Appendix H (Metric) Units

MATERIAL OR CONSTRUCTION ITEM	TESTS	METHOD OF ACCEPTANCE & RELATED IMs	QUALITY CONTROL					INDEPENDENT ASSURANCE & VERIFICATION S&T						REMARKS
			SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	S&T TYPE	SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	
SOURCE INSPECTION														
Aggregate-Fine (4110)		AS 209												
Aggregate-Coarse (4115)		AS 209												
Granular Backfill (4133)		AS 209												
Portland Cement (4101)	Quality	AS 401												
Fly Ash (4108)	Quality	AS 491.17												
Mixing Water (4102)	Quality								RCE	1/project	1 L	CTRL	731	Not required for potable water from Municipal Supply
GGBFS (Ground Granulated Blast Furnace Slag)	Quality	AS 491.14												
Air Entraining Admixture	Quality	AS 403												
Retarding Admixture	Quality	AS 403												
Water reducing Admixture	Quality	AS 403												
Curing Compound, White (4105)	Lab Tested	405						V	DME	1/batch	1 qt	CTRL		
Curing Compound, Clear (4105)		AS 405.07												

AS-Approved Source
ASD-Approved Shop Drawing
S&T-Sampling & Testing

Cert A-Type A Certification
Cert C-Type C Certification
Cert D-Type D Certification

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CONTR-Contractor

IA-Independent Assurance
V-Verification

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Sampling & Testing Guide-Minimum Frequency

STRUCTURAL CONCRETE, REINFORCEMENT, FOUNDATIONS & SUBSTRUCTURES, CONCRETE STRUCTURES, CONCRETE FLOORS, & CONCRETE BOX, ARCH & CIRCULAR CULVERTS

Sections 2403, 2404, 2405, 2406, 2412, & 2415

October 16, 2007
Supersedes April 17, 2007

Matls. IM 204
Appendix H (Metric) Units

MATERIAL OR CONSTRUCTION ITEM	TESTS	METHOD OF ACCEPTANCE & RELATED IMs	QUALITY CONTROL					INDEPENDENT ASSURANCE & VERIFICATION S&T						REMARKS
			SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	S&T TYPE	SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	
SOURCE INSPECTION														
Preformed Joint Sealer (4136)	Lab-Tested	AS 436.02 436.05												
Reinforcing Steel Bars (4151)	Quality	AS 451												
Steel Pile (4167)	Quality	467												
Concrete Pile (4166)	Quality	AS 570												
Timber Pile (4165)	Quality	Cert A AS 462												
Timber (4162) & Lumber (4163)		Treated-Cert A 462												
Concrete Anchors	Quality	AS 453.09												
Epoxy Grout	Quality	AS 491.11												
Concrete Sealer	Quality	AS 491.12												
Subdrain Pipe (4143)	Quality	AS 443, 448												
Neoprene Bearing Pads (4195)		AS 495.03												
Bronze Bearing Plates (4190.03)		ASD/Cert A												

AS-Approved Source
ASD-Approved Shop Drawing
S&T-Sampling & Testing

Cert A-Type A Certification
Cert C-Type C Certification
Cert D-Type D Certification

RCE-Resident Construction Engineer/Project Engineer
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V-Verification

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STRUCTURAL CONCRETE, REINFORCEMENT, FOUNDATIONS & SUBSTRUCTURES, CONCRETE STRUCTURES, CONCRETE FLOORS, & CONCRETE BOX, ARCH & CIRCULAR CULVERTS

Sections 2403, 2404, 2405, 2406, 2412, & 2415

October 16, 2007
Supersedes April 17, 2007

Matls. IM 204
Appendix H (Metric) Units

MATERIAL OR CONSTRUCTION ITEM	TESTS	METHOD OF ACCEPTANCE & RELATED IMs	QUALITY CONTROL					INDEPENDENT ASSURANCE & VERIFICATION S&T						REMARKS
			SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	S&T TYPE	SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPT.	
SOURCE INSPECTION														
Steel Masonry Plate (4152)		ASD/Cert A												
Precast Units (2407)	Quality	AS 570												
Anchor Bolts (lighting, signing, handrail) (4153)	Lab Tested	ASD												
Structural Steel (4152)	Quality	Cert A												Monitor Sample According to plans or other instructions
Aluminum Bridge Rail & Anchor Assembly		ASD												
Conduit (Electrical) (4185.10) Steel)		AS												
Conduit (Plastic) (4185.10)	Lab Tested							V	DME	1/size	1 m with coupling	C TRL		
Bentonite		Visual												
Flowable Mortar	Lab Tested	Approved Trial Mix 525, 375												Tested by DME

AS-Approved Source
ASD-Approved Shop Drawing
S&T-Sampling & Testing

Cert A-Type A Certification
Cert C-Type C Certification
Cert D-Type D Certification

RCE-Resident Construction Engineer/Project Engineer
DME-District Materials Engineer
CTRL-Central Materials Office
CONTR-Contractor

IA-Independent Assurance
V-Verification

NOTE: RCE/CONTR indicates that the Contractor shall assist in the sampling at the direction of and witnessed by the Project Engineer.

Sampling & Testing Guide-Minimum Frequency

STRUCTURAL CONCRETE, REINFORCEMENT, FOUNDATIONS & SUBSTRUCTURES, CONCRETE STRUCTURES, CONCRETE FLOORS, & CONCRETE BOX, ARCH & CIRCULAR CULVERTS

Sections 2403, 2404, 2405, 2406, 2412, & 2415

October 16, 2007
Supersedes April 17, 2007

Matls. IM 204
Appendix H (Metric) Units

MATERIAL OR CONSTRUCTION ITEM	TESTS	METHOD OF ACCEPTANCE & RELATED IMs	QUALITY CONTROL					INDEPENDENT ASSURANCE & VERIFICATION S&T						REMARKS
			SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	S&T TYPE	SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	
PLANT INSPECTION														
Aggregate- Fine (4110)	Gradation Deck	302, 306 336	CONTR	IM 528	IM 301	CONTR	800240	IA V	DME RCE/ CONTR	1/750 m³ Sample & Test 1/deck/wk	IM 301 IM 301	DME RCE		May use System App.
	Gradation All other		CONTR	IM 528	IM 301	CONTR		IA V	DME RCE/ CONTR	1/750 m³ Sample 1/wk Test 1st day +20%	IM 301 IM 301	DME RCE		May use System App.
	Moisture	308, 528	CONTR	1/lot	1000 gm	CONTR								See IM 528 if Moisture Probe is used
	Sp. Gr.	307	CONTR	IM 528	1000 gm	CONTR								
	Quality	AS 209												
Aggregate- Coarse (4115)	Gradation Deck	302, 306 336	CONTR	IM 528	IM 301	CONTR		IA V	DME RCE/ CONTR	1/750 m³ Sample & Test 1/deck/wk	IM 301 IM 301	DME RCE		May use System App.
	Gradation All other		CONTR	IM 528	IM 301	CONTR		IA V	DME RCE/ CONTR	1/750 m³ Sample 1/wk Test 1st day +20%k	IM 301 IM 301	DME RCE		May use System App.
	Moisture	308, 528	CONTR	1/lot	2000gm	CONTR								
	Sp. Gr.	307	CONTR	IM 528	2000gm	CONTR								
	Quality	AS 209						V	DME	1/750 m³	22 kg	CTRL		(1)
Portland Cement	w/c ratio	528	CONTR	1/pour		CONTR								
	Quality	AS Cert D						V	DME	1/750 m³	7 kg	CTRL		(1)

AS-Approved Source
ASD-Approved Shop Drawing
S&T-Sampling & Testing

Cert A-Type A Certification
Cert C-Type C Certification
Cert D-Type D Certification

RCE-Resident Construction Engineer/Project Engineer
DME-District Materials Engineer
CTRL-Central Materials Office
CONTR-Contractor

IA-Independent Assurance
V-Verification

(1) These verification samples for concrete materials not required when mix quantity is less than 40 m³.

NOTE: RCE/CONTR indicates that the Contractor shall assist in the sampling at the direction of and witnessed by the Project Engineer.

STRUCTURAL CONCRETE, REINFORCEMENT, FOUNDATIONS & SUBSTRUCTURES, CONCRETE STRUCTURES, CONCRETE FLOORS, & CONCRETE BOX, ARCH & CIRCULAR CULVERTS

Sections 2403, 2404, 2405, 2406, 2412, & 2415

October 16, 2007
Supersedes April 17, 2007

Matls. IM 204
Appendix H (Metric) Units

MATERIAL OR CONSTRUCTION ITEM	TESTS	METHOD OF ACCEPTANCE & RELATED IMs	QUALITY CONTROL					INDEPENDENT ASSURANCE & VERIFICATION S&T						REMARKS
			SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	S&T TYPE	SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	
PLANT INSPECTION														
Fly Ash	Quality	AS Cert D		Ea Load			800240							
GGBFS(Ground Granulated Blast Furnace Slag)	Quality	AS Cert D		Ea Load				V	DME	1/750 m^3	7 kg	CTRL		
Air Entraining Admixture (4103)		AS 403						V	RCE	1/batch	0.5 L	CTRL		(1) Sample lots not previously reported or as required by DME
Retarding Admixture		AS 403						V	RCE	1/batch	0.5 L	CTRL		
Water Reducing Admixture (4103)		AS 403						V	RCE	1/batch	0.5 L	CTRL		
GRADE INSPECTION														
Plastic Concrete	Air Content	316, 327					M145*	IA V	DME RCE	1/750 m^3 1/25 m^3		DME RCE		DME may adjust
	Slump	317, 327						IA V	DME RCE	1/750m^3 1/25 m^3		Witness Only RCE		DME may adjust
	Beams	316, 327, 328							RCE	2/placement		RCE		If required per 2403.18 & 2403.19
	Cylinders								DME	3/project		DME		Primary Projects Only (Information only)

AS-Approved Source
ASD-Approved Shop Drawing
S&T-Sampling & Testing

Cert A-Type A Certification
Cert C-Type C Certification
Cert D-Type D Certification

RCE-Resident Construction Engineer/Project Engineer
DME-District Materials Engineer
CTRL-Central Materials Office
CONTR-Contractor

IA-Independent Assurance
V-Verification

(1) These verification samples for concrete materials not required when mix quantity is less than 40 m^3.

NOTE: RCE/CONTR indicates that the Contractor shall assist in the sampling at the direction of and witnessed by the Project Engineer.

*Available from the Office of Construction.

Sampling & Testing Guide-Minimum Frequency

STRUCTURAL CONCRETE, REINFORCEMENT, FOUNDATIONS & SUBSTRUCTURES, CONCRETE STRUCTURES, CONCRETE FLOORS, & CONCRETE BOX, ARCH & CIRCULAR CULVERTS

Sections 2403, 2404, 2405, 2406, 2412, & 2415

October 16, 2007
Supersedes April 17, 2007

Matls. IM 204
Appendix H (Metric) Units

MATERIAL OR CONSTRUCTION ITEM	TESTS	METHOD OF ACCEPTANCE & RELATED IMs	QUALITY CONTROL					INDEPENDENT ASSURANCE & VERIFICATION S&T						REMARKS
			SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	S&T TYPE	SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	
GRADE INSPECTION														
Reinforcing Steel (4151)	Quality	AS Cert A		Each Shipment			Field Book	V	DME	IM 451	2 m	CTRL		
Reinforcing Steel Epoxy Coated (4151)	Quality	AS Cert A		Each Shipment			Field Book	V	DME	1 bar	2 m	CTRL		Will be acceptance tested for coating
Steel Pile (4167)	Quality	AS Cert A		Each Heat			Field Book	V	DME	IM 467		CTRL		
Timber Pile (4165)	Quality	AS 462 Cert A						V	DME	IM 462		CRTL		No grade requirement Charge numbers on butt end.
Anchor Bolts (lighting, signing, handrail)	Lab Tested	ASD						V	DME	1/project	1 bolt w/nut & washer	CTRL		Sample only if not source inspected
Steel Masonry Plates (4152)		ASD Cert A		Each Shipment			Field Book							Approved by Materials Department
Bronze Bearing Plates (4190.03)	Lab Tested							V	DME	1/project	1 only	CTRL		Sample only if not source inspected
Neoprene Bearing Pads (4195)		AS 495.03		Each Shipment			820905							
Alum. Bridge Rail & Anchor Assembly		ASD		Each Shipment			Field Book							Approved By Materials Dept.
Drains (Std Steel Pipe)(as per plan)	Dimensions Galvanized	ASD Visual 332						V	DME	1/project		DME	Test Report	

AS-Approved Source
ASD-Approved Shop Drawing
S&T-Sampling & Testing

Cert A-Type A Certification
Cert C-Type C Certification
Cert D-Type D Certification

RCE-Resident Construction Engineer/Project Engineer
DME-District Materials Engineer
CTRL-Central Materials Office
CONTR-Contractor

IA-Independent Assurance
V-Verification

NOTE: RCE/CONTR indicates that the Contractor shall assist in the sampling at the direction of and witnessed by the Project Engineer.

STRUCTURAL CONCRETE, REINFORCEMENT, FOUNDATIONS & SUBSTRUCTURES, CONCRETE STRUCTURES, CONCRETE FLOORS, & CONCRETE BOX, ARCH & CIRCULAR CULVERTS

Sections 2403, 2404, 2405, 2406, 2412, & 2415

MATERIAL OR CONSTRUCTION ITEM	TESTS	METHOD OF ACCEPTANCE & RELATED IMs	QUALITY CONTROL					INDEPENDENT ASSURANCE & VERIFICATION S&T						REMARKS
			SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	S&T TYPE	SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	
GRADE INSPECTION														
Timber (4162) & Lumber (4163)	Quality	AS Treated-Cert A 462		Each Shipment										
Subdrain Pipe (4143)	Quality	AS Cert D 443, 448		Each Shipment										
Flowable Mortar (2506)	Flow Test	375	RCE	As needed for Project Control		RCE	830211							Mix Design approval by DME
Bentonite	Flow Test	Visual 375				RCE								
Smoothness (2317)	Profilometer	Cert. Test Rpt. 341	CONTR	Each Project	Each Wheelpath	CONTR	821301	V		10%		DME		

AS-Approved Source
ASD-Approved Shop Drawing
S&T-Sampling & Testing

Cert A-Type A Certification
Cert C-Type C Certification
Cert D-Type D Certification

RCE-Resident Construction Engineer/Project Engineer
DME-District Materials Engineer
CTRL-Central Materials Office
CONTR-Contractor

IA-Independent Assurance
V-Verification

NOTE: RCE/CONTR indicates that the Contractor shall assist in the sampling at the direction of and witnessed by the Project Engineer.

Sampling & Testing Guide-Minimum Frequency

CONCRETE DRILLED SHAFT FOUNDATIONS

SS-01032

October 17, 2006
Supersedes October 18, 2005

Matls. IM 204
Appendix I

MATERIAL OR CONSTRUCTION ITEM	TESTS	METHOD OF ACCEPTANCE & RELATED IMs	QUALITY CONTROL					INDEPENDENT ASSURANCE & VERIFICATION S&T						REMARKS
			SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	S&T TYPE	SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	
SOURCE INSPECTION														
Aggregate-Fine (4110)		AS 209												
Aggregate-Coarse (4115)		AS 209												
Portland Cement (4101)	Quality	AS 401												
Fly Ash (4108)	Quality	AS 491.17												
Mixing Water (4102)	Quality								DME	1/project	1 quart	CTRL	731	Not required for potable water from Municipal Supply
Air Entraining Admixture	Quality	AS 403												
Retarding Admixture	Quality	AS 403												
Reinforcing Steel Bars (4151)	Quality	AS 451												
Permanent Casing	Quality	Cert A												According to plans or other instructions
Drilling Slurry		Visual DS-01038												

AS-Approved Source
ASD-Approved Shop Drawing
S&T-Sampling & Testing

Cert A-Type A Certification
Cert C-Type C Certification
Cert D-Type D Certification

RCE-Resident Construction Engineer/Project Engineer
DME-District Materials Engineer
CTRL-Central Materials Office
CONTR-Contractor

IA-Independent Assurance
V-Verification

Quality samples not required when mix quantity is less than 50 cu. yd.

Sampling & Testing Guide-Minimum Frequency

CONCRETE DRILLED SHAFT FOUNDATIONS

SS-01032

October 17, 2006
Supersedes October 18, 2005

Matls. IM 204
Appendix I

MATERIAL OR CONSTRUCTION ITEM	TESTS	METHOD OF ACCEPTANCE & RELATED IMs	QUALITY CONTROL					INDEPENDENT ASSURANCE & VERIFICATION S&T						REMARKS
			SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	S&T TYPE	SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	
PLANT INSPECTION														
Aggregate- Fine (4110)	Gradation	302, 306 336	CONTR	3/lot	IM 301	CONTR	800240	IA V	DME RCE/ CONTR	1/1000 cy 1^{st} day+20%	IM 301 IM 301	DME RCE		System Approach Applicable
	Moisture	308, 528	CONTR	1/lot	1000 gm	CONTR								See IM 528 if Moisture Probe is used
	Sp. Gr.	307	CONTR	IM 528	1000 gm	CONTR								
	Quality	AS 209												
Aggregate- Coarse (4115)	Gradation	302, 306 336	CONTR	3/lot	IM 301	CONTR		IA	DME RCE/ CONTR	1/1000 cy 1^{st} day+20%	IM 301 IM 301	DME RCE		System Approach Applicable
	Moisture	308, 528	CONTR	1/lot	2000gm	CONTR								
	Sp. Gr.	307	CONTR	IM 528	2000gm	CONTR								
	Quality	AS 209						V	DME	1/1000 cy	50 lb	CTRL		
Portland Cement	w/c ratio	528	CONTR	1/pour		CONTR								
	Quality	AS Cert D						V	DME	1/1000 cy	15 lb	CTRL		
Fly Ash	Quality	AS Cert D		Each Load			800240							
Air-Entraining Admixture (4103)		AS 403						V	DME	1/batch	1 pint	CTRL		Sample lots not previously reported or as required by DME
Retarding Admixture		AS 403						V	DME	1/batch	1 pint	CTRL		Sample lots not previously reported or as required by DME

AS-Approved Source
ASD-Approved Shop Drawing
S&T-Sampling & Testing

Cert A-Type A Certification
Cert C-Type C Certification
Cert D-Type D Certification

RCE-Resident Construction Engineer/Project Engineer
DME-District Materials Engineer
CTRL-Central Materials Office
CONTR-Contractor

IA-Independent Assurance
V-Verification

Quality samples not required when mix quantity is less than 50 cu. yd.

Sampling & Testing Guide-Minimum Frequency

CONCRETE DRILLED SHAFT FOUNDATIONS

SS-01032

MATERIAL OR CONSTRUCTION ITEM	TESTS	METHOD OF ACCEPTANCE & RELATED IMs	QUALITY CONTROL					INDEPENDENT ASSURANCE & VERIFICATION S&T						REMARKS
			SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	S&T TYPE	SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	
GRADE INSPECTION														
Plastic Concrete	Air Content	316, 327					E145*	IA	RCE	1/30 cy		RCE		DME may adjust
	Slump	317, 327	RCE	1/30 cy		RCE		IA	DME	1/30 cy		RCE		DME may adjust
	Cylinders								DME	3/project		DME		Primary Projects Only (Information only)
Reinforcing Steel (4151)	Quality	AS Cert A		Each Shipment			Field Book							
Metal Access Pipe		Visual												
Drilling Slurry	Density, Viscosity, pH, Sand Content	387	CONTR	1/ 2 hours		CONTR								1/ 4 hours if consistent
Crosshole Sonic Log Test		SS-01032	CONTR	1/shaft		CONTR	Report, Analysis, Inter-pretation							

AS-Approved Source
ASD-Approved Shop Drawing
S&T-Sampling & Testing

Cert A-Type A Certification
Cert C-Type C Certification
Cert D-Type D Certification

RCE-Resident Construction Engineer/Project Engineer
DME-District Materials Engineer
CTRL-Central Materials Office
CONTR-Contractor

IA-Independent Assurance
V-Verification

Quality samples not required when mix quantity is less than 50 cu. yd.

*Available from the Office of Construction.

Sampling & Testing Guide-Minimum Frequency

October 17, 2006
Supersedes April 18, 2006

COLD-IN-PLACE RECYCLED ASPHALT PAVEMENT

Section 2318, DS-01076

Matls. IM 204
Appendix K (US) Units

MATERIAL OR CONSTRUCTION ITEM	TESTS	METHOD OF ACCEPTANCE & RELATED IMs	QUALITY CONTROL					INDEPENDENT ASSURANCE & VERIFICATION S&T						REMARKS
			SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	S&T TYPE	SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	
SOURCE INSPECTION														
Asphalt Stabilizing Agent	Quality	AS 437												
GRADE INSPECTION														
RAP (2318.02)	Max Size		RCE	1st day + 1/week	10 lb	RCE		V						
Stabilizing Agent (Engr. Emulsion)	Quality Residue	Cert D 360						V	RCE/CONTR RCE/CONTR	1/project 1/day (2)	1 qt 1 qt	CTRL DME		Must use plastic bottle for emulsion
Stabilizing Agent (Foamed Asphalt)	Quality DSR	Cert D						V	RCE/CONTR RCE/CONTR	1/project 1/day (2)	1 qt 1 qt	CTRL DME		
Stabilizing Agent (Std. Emulsion)	Quality Residue	Cert D 360						V	RCE	1/day(2)	1 qt	DME		Must use plastic bottle for emulsion
Uncompacted Mixture	Moisture Density	504 504						V	RCE	1/lot	30 lb	DME		Sealed Container
Compacted Mixture	Moisture(1) Density	504 504	CONTR CONTR	10/lot 10/lot		CONTR CONTR								Witnessed by RCE
Smoothness		DS-01076 only												

AS-Approved Source
ASD-Approved Shop Drawing
S&T-Sampling & Testing

Cert A-Type A Certification
Cert C-Type C Certification
Cert D-Type D Certification

RCE-Resident Construction Engineer/Project Engineer
DME-District Materials Engineer
CTRL-Central Materials Office
CONTR-Contractor

IA-Independent Assurance
V-Verification

(1) See IM 504 for Day 1 moisture correction factor.
(2) The sample from the first day and 1/week shall be forwarded to the District Laboratory for testing. The other samples shall be retained for submission in the event of a failing test result.

Sampling & Testing Guide-Minimum Frequency

October 17, 2006
Supersedes April 18, 2006

COLD-IN-PLACE RECYCLED ASPHALT PAVEMENT

Section 2318

Matls. IM 204
Appendix K (Metric) Units

MATERIAL OR CONSTRUCTION ITEM	TESTS	METHOD OF ACCEPTANCE & RELATED IMs	QUALITY CONTROL					INDEPENDENT ASSURANCE & VERIFICATION S&T						REMARKS
			SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	S&T TYPE	SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	
SOURCE INSPECTION														
Asphalt Stabilizing Agent (2318.02)	Quality	AS 437												
GRADE INSPECTION														
RAP 2318.02	Max Size		RCE	1st day + 1/ week	5 kg	RCE								
Stabilizing Agent (Engr. Emulsion)	Quality Residue	Cert D 360	RCE	1/day (2)	1 L	DME		V	RCE	1/project	1 L	CTRL		Must use plastic bottle for emulsion
Stabilizing Agent (Foamed Asphalt)	Quality DSR	Cert D	RCE	1/day (2)	90 ml tin	DME		V	RCE	1/project	1 L	CTRL		
Stabilizing Agent (Std. Emulsion)	Quality Residue	Cert D 360	RCE	1/day (2)	1 L	DME								Must use plastic bottle for emulsion
Uncompacted Mixture (2318.04)	Moisture Density	504 504	RCE RCE	1/lot 1/lot	14 kg 14 kg	DME DME								Sealed Container
Compacted Mixture (2318.04)	Moisture(1) Density	504 504	CONTR CONTR	10/lot 10/lot		CONTR CONTR								Witnessed by RCE

AS-Approved Source	Cert A-Type A Certification	RCE-Resident Construction Engineer/Project Engineer	IA-Independent Assurance
ASD-Approved Shop Drawing	Cert C-Type C Certification	DME-District Materials Engineer	V-Verification
S&T-Sampling & Testing	Cert D-Type D Certification	CTRL-Central Materials Office	
		CONTR-Contractor	

(1) See IM 504 for Day 1 moisture correction factor.

(2) The sample from the first day and 1/week shall be forwarded to the District Laboratory for testing. The other samples shall be retained for submission in the event of a failing test result.

Sampling & Testing Guide-Minimum Frequency

October 17, 2006
Supersedes October 18, 2005

GRANULAR SURFACING/DRIVEWAY SURFACING

Sections 2312 & 2315

Matls. IM 204
Appendix L (US) Units

MATERIAL OR CONSTRUCTION ITEM	TESTS	METHOD OF ACCEPTANCE & RELATED IMs	QUALITY CONTROL					INDEPENDENT ASSURANCE & VERIFICATION S&T						REMARKS
			SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	S&T TYPE	SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	
SOURCE INSPECTION														
Class C Gravel (4120.03)	Gradation Quality	AS 209												
Class A Crushed Stone (4120.04)	Gradation Quality	AS 209												
Class B Crushed Stone (4120.05)	Gradation Quality	AS 209												
Class D Crushed Stone (4120.06)	Gradation Quality	AS 209												
Aggregate for Type B, AC or cold laid Bituminous Concrete (for driveways only)	Gradation Quality	AS 209												
Crushed Stone Base (For driveways only) (4122)	Gradation Quality	AS 209												
GRADE INSPECTION														
Dimensions	Thickness Width Cross Slope		RCE	3/mi.			Field Book							

AS-Approved Source
ASD-Approved Shop Drawing
S&T-Sampling & Testing

Cert A-Type A Certification
Cert C-Type C Certification
Cert D-Type D Certification

RCE-Resident Construction Engineer/Project Engineer
DME-District Materials Engineer
CTRL-Central Materials Office
CONTR-Contractor

IA-Independent Assurance
V-Verification

Sampling & Testing Guide-Minimum Frequency

GRANULAR SURFACING/DRIVEWAY SURFACING

Sections 2312 & 2315

MATERIAL OR CONSTRUCTION ITEM	TESTS	METHOD OF ACCEPTANCE & RELATED IMs	QUALITY CONTROL					INDEPENDENT ASSURANCE & VERIFICATION S&T						REMARKS
			SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	S&T TYPE	SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	
SOURCE INSPECTION														
Class C Gravel (4120.03)	Gradation Quality	AS 209												
Class A Crushed Stone (4120.03)	Gradation Quality	AS 209												
Class B Crushed Stone (4120.03)	Gradation Quality	AS 209												
Class D Crushed Stone (4120.03)	Gradation Quality	AS 209												
Aggregate for Type B, AC or cold laid Bituminous Concrete (For driveways only)	Gradation Quality	AS 209												
Crushed Stone Base (For driveways only) (4122)	Gradation Quality	AS 209												
GRADE INSPECTION														
Dimensions	Thickness Width Cross Slope		RCE	2/km			Field Book							

AS-Approved Source
ASD-Approved Shop Drawing
S&T-Sampling & Testing

Cert A-Type A Certification
Cert C-Type C Certification
Cert D-Type D Certification

RCE-Resident Construction Engineer/Project Engineer
DME-District Materials Engineer
CTRL-Central Materials Office
CONTR-Contractor

IA-Independent Assurance
V-Verification

Sampling and Testing Guide-Minimum Frequency

October 16, 2007
Supersedes October 17, 2006

CONCRETE BRIDGE FLOOR REPAIR & OVERLAY & SURFACING

Section 2413

Matls. IM 204
Appendix M

MATERIAL OR CONSTRUCTION ITEM	TESTS	METHOD OF ACCEPTANCE & RELATED IMs	QUALITY CONTROL					INDEPENDENT ASSURANCE & VERIFICATION S&T						REMARKS
			SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	S&T TYPE	SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	
SOURCE INSPECTION														
Aggregates-Fine (4110)		AS 209												
Aggregates-Coarse (4115)		AS 209												
Portland Cement (4101)	Quality	AS 401												
Mixing Water (4102)	Quality	Lab Tested						V	RCE	1/source	1 qt.	CTRL		Not needed for potable Municipal Water
Air Entraining Admixture (4103)	Quality	AS 403												
Water Reducing Admixture (4103)	Quality	AS 403												
Retarding Admixture (4103)		AS 403												
Curing Compound (4105)	Lab Tested	405						V	DME	1/batch	1 pt	CTRL		Sample lots not previously reported
PLANT INSPECTION														
Aggregate-Fine (4110)		AS Cert A												
Aggregate-Coarse (4115)	Quality	AS Cert A						V	DME	1/project	50 lb	CTRL		DME may adjust frequency
Portland Cement (4101)	Quality	AS Cert D						V	DME	1/project	15 lb	CTRL		
Air Entraining Admixture (4103)		AS 403						V	RCE	Each batch	1 pt	CTRL		Sample if not previously reported
Water Reducing Admixture (4103)		AS 403						V	RCE	Each batch	1 pt	CTRL		Sample if not previously reported
Retarding Admixture (4103)		AS 403						V	RCE	Each batch	1 pt	CTRL		Sample if not previously reported

AS-Approved Source
ASD-Approved Shop Drawing
S&T-Sampling & Testing

Cert A-Type A Certification
Cert C-Type C Certification
Cert D-Type D Certification

RCE-Resident Construction Engineer/Project Engineer
DME-District Materials Engineer
CTRL-Central Materials Office
CONTR-Contractor

IA-Independent Assurance
V-Verification

October 16, 2007
Supersedes October 17, 2006

CONCRETE BRIDGE FLOOR REPAIR & OVERLAY & SURFACING

Section 2413

MATERIAL OR CONSTRUCTION ITEM	TESTS	METHOD OF ACCEPTANCE & RELATED IMs	QUALITY CONTROL					INDEPENDENT ASSURANCE & VERIFICATION S&T						REMARKS
			SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	S&T TYPE	SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	
GRADE INSPECTION														
Plastic Concrete (2413)	Air	318, 327						V	RCE	1/100 sy		RCE		
	Slump	317, 327						V	RCE	1/100 sy		RCE		
	Density	358						V	RCE	See Note		RCE		For Class O PCC only. (1)
	Thickness								RCE	3/50 sy		RCE		
	Cylinders							V	DME	3/project		DME		Primary Projects only (Information Only)
Concrete Sealer (2413.09)	Quality	AS 491.12												

AS-Approved Source
ASD-Approved Shop Drawing
S&T-Sampling & Testing

Cert A-Type A Certification
Cert C-Type C Certification
Cert D-Type D Certification

RCE-Resident Construction Engineer/Project Engineer
DME-District Materials Engineer
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CONTR-Contractor

IA-Independent Assurance
V-Verification

(1) Nuclear density testing frequency for each placement shall be one test within 5 feet (1500 mm) of the beginning and end of the placement and additional tests shall be equally spaced a maximum of 100 feet (30 000 mm) throughout the length of the placement. Each placement shall have a minimum of three nuclear density tests.

Sampling & Testing Guide-Minimum Frequency

October 17, 2006
Supersedes April 19, 2005

SURFACE TREATMENT (Seal Coat, Slurry, Joint Repair, Crack Filling, Fog Seal)

Section 2307, 2319, 2540, 2544, 2306, 2308

Matls. IM 204
Appendix P (US) Units

MATERIAL OR CONSTRUCTION ITEM	TESTS	METHOD OF ACCEPTANCE & RELATED IMs	QUALITY CONTROL					INDEPENDENT ASSURANCE & VERIFICATION S&T						REMARKS
			SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	S&T TYPE	SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	
SOURCE INSPECTION														
Aggregates (4125)	Quality Gradation	AS 209												
Emulsions/ Cutbacks	Quality	AS												
Emulsion & Aggregate	Compatibility	349							DME	1/ source	1 qt & 10lb	DME/ CTRL		Seal Coat
Emulsion & Aggregate	Mix Design													Slurry
GRADE INSPECTION														
Aggregate	Quality Gradation	Cert D 301						V	DME	1/proj.	50 lb	CTRL		Seal Coat
Emulsion	Quality Residue	Cert D 323, 360	RCE	1/20,000 gal	1 qt	DME	Fieldbook(2)							Seal Coat/Slurry(1)
	Compatibility	349	RCE	1st day+ 1/week	1 qt & 10 b	DME								Seal Coat
Cutback	Quality Viscosity	Cert D 323, 329	RCE	1/20,000 gal	1 qt	DME	Fieldbook(2)							
	Anti-Strip	AS 323, 374												

AS-Approved Source
ASD-Approved Shop Drawing
S&T-Sampling & Testing

Cert A-Type A Certification
Cert C-Type C Certification
Cert D-Type D Certification

RCE-Resident Construction Engineer/Project Engineer
DME-District Materials Engineer
CTRL-Central Materials Office
CONTR-Contractor

IA-Independent Assurance
V-Verification

Emulsion samples in plastic bottles only.
No samples required for joint repair, crack filling, and fog seal. Acceptance based on certification only.
(1) Samples of emulsion for slurry are required for full width placement only.
(2) Log all shipments

Sampling & Testing Guide-Minimum Frequency

October 16, 2007
Supersedes October 17, 2006

BASE REPAIR (2212), PAVEMENT REPAIR (PATCHES)

Sections 2529 & 2530

Matls. IM 204
Appendix T

MATERIAL OR CONSTRUCTION ITEM	TESTS	METHOD OF ACCEPTANCE & RELATED IMs	QUALITY CONTROL					INDEPENDENT ASSURANCE & VERIFICATION S&T						REMARKS
			SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	S&T TYPE	SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	
SOURCE INSPECTION														
Aggregates Fine (4110)		AS 209												
Aggregates Coarse (4115)		AS 209												
Portland Cement (4101)	Quality	AS 401												
Fly Ash (4108)	Quality	AS 491.17												
GGBFS (Ground Granulated Blast Furnace Slag)	Quality	AS 491.14												
Curing Compound (4105)	Lab Tested	405												
Air Entraining Admixture (4103)	Quality	AS 403												
Granular Backfill	Gradation Quality	AS CERT AS CERT												
Drain Tubing	Quality	AS 443												
Epoxy Grout		AS 491.11												
Joint Seal (4136.02)	Lab Tested	436.01 AS 436.02												
Backer Rod (4136.02)		AS 436.04												
Steel Reinforcing	Quality	AS 451												

AS-Approved Source
ASD-Approved Shop Drawing
S&T-Sampling & Testing

Cert A-Type A Certification
Cert C-Type C Certification
Cert D-Type D Certification

RCE-Resident Construction Engineer/Project Engineer
DME-District Materials Engineer
CTRL-Central Materials Office
CONTR-Contractor

IA-Independent Assurance
V-Verification

Sampling & Testing Guide-Minimum Frequency

October 16, 2007
Supersedes October 17, 2006

BASE REPAIR (2212), PAVEMENT REPAIR (PATCHES)

Sections 2529 & 2530

Matls. IM 204
Appendix T

MATERIAL OR CONSTRUCTION ITEM	TESTS	METHOD OF ACCEPTANCE & RELATED IMs	QUALITY CONTROL					INDEPENDENT ASSURANCE & VERIFICATION S&T						REMARKS
			SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	S&T TYPE	SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	
PLANT INSPECTION														
Aggregates-Coarse (4115)	Grad	302 306 336	CONTR	1/lot	IM 301	CONTR		V	RCE/ CONTR	1st day +20%	IM 301	RCE		
	Moist	308	CONTR	1 / half day	1000 gm	CONTR								
	Sp. Gr.	307	CONTR	IM 527	1000 gm	CONTR								
	Quality	AS 209												
Aggregate- Fine (4110)	Gradation	302, 306 336	CONTR	1/lot	IM 301	CONTR	830211	V	RCE/ CONTR	1st day+ 20%	IM 301 IM 301	RCE		
	Moisture	308, 528	CONTR	1/lot	1000 gm	CONTR	830211							See IM 528 if Moisture Probe is used
	Sp. Gr.	307	CONTR	IM 528	1000 gm	CONTR	830211							
	Quality	AS 209												
Portland Cement (4101)	Quality	AS CERT D		Each Load										
Fly Ash	Quality	AS CERT D		Each Load										
Air Entraining Admixture		AS 403						V	DME	1/batch	1 pt	CTRL		Sample lots not previously reported or as directed by DME
Water Reducing Admixture		AS 403						V	DME	1/batch	1 pt	CTRL		
Retarding Admixture		AS 403						V	DME	1/batch	1 pt	CTRL		

AS-Approved Source
ASD-Approved Shop Drawing
S&T-Sampling & Testing

Cert A-Type A Certification
Cert C-Type C Certification
Cert D-Type D Certification
CONTR-Contractor

RCE-Resident Construction Engineer/Project Engineer
DME-District Materials Engineer
CTRL-Central Materials Office

IA-Independent Assurance
V-Verification

Sampling & Testing Guide-Minimum Frequency

October 16, 2007
Supersedes October 17, 2006

BASE REPAIR (2212), PAVEMENT REPAIR (PATCHES)

Sections 2529 & 2530

Matls. IM 204
Appendix T

MATERIAL OR CONSTRUCTION ITEM	TESTS	METHOD OF ACCEPTANCE & RELATED IMs	QUALITY CONTROL					INDEPENDENT ASSURANCE, & VERIFICATION S&T						REMARKS
			SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	S&T TYPE	SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	
GRADE INSPECTION														
Uncompacted HMA Mixture		Scale ticket with JMF number												Job Mix Formula (JMF) approved by DME
Plastic Concrete	Air Slump	318 327 318 327						V V	RCE RCE	2/half day 2/half day		RCE RCE		
Reinforcing Steel Epoxy-Coated Steel	Quality Quality	AS 451 AS 451		Each Shipment										
Calcium Chloride	Concentr.	373	RCE	1/lot		RCE								
Smoothness for Compacted HMA or Hardened Conc. (2529.10)		341	CONTR			CONTR								Approval by DME See Plans/Specs for exclusions

AS-Approved Source
ASD-Approved Shop Drawing
S&T-Sampling & Testing

Cert A-Type A Certification
Cert C-Type C Certification
Cert D-Type D Certification

RCE-Resident Construction Engineer/Project Engineer
DME-District Materials Engineer
CTRL-Central Materials Office
CONTR-Contractor

IA-Independent Assurance
V-Verification

Sampling & Testing Guide-Minimum Frequency

October 17, 2006
Supersedes October 18, 2005

GRANULAR SHOULDERS

Section 2121

Matls. IM 204
Appendix U (US) Units

MATERIAL OR CONSTRUCTION ITEM	TESTS	METHOD OF ACCEPTANCE & RELATED IMs	QUALITY CONTROL					INDEPENDENT ASSURANCE & VERIFICATION S&T						REMARKS
			SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	S&T TYPE	SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	
SOURCE INSPECTION														
Aggregate (4120.02)	Gradation Quality	AS 209												
Aggregate (Paved Shoulder Fillets) (4120.07)	Gradation Quality	AS 209												
GRADE INSPECTION														
Dimensions	Thickness Width Cross Section	Template	RCE	3/mile 3/mile 3/mile		RCE	Field Book							
Aggregate (Paved Shoulder Fillets)	Gradation	Certification												

AS-Approved Source
ASD-Approved Shop Drawing
S&T-Sampling & Testing

Cert A-Type A Certification
Cert C-Type C Certification
Cert D-Type D Certification

RCE-Resident Construction Engineer/Project Engineer
DME-District Materials Engineer
CTRL-Central Materials Office
CONTR-Contractor

IA-Independent Assurance
V-Verification

GRANULAR SHOULDERS

Section 2121

MATERIAL OR CONSTRUCTION ITEM	TESTS	METHOD OF ACCEPTANCE & RELATED IMs	QUALITY CONTROL					INDEPENDENT ASSURANCE & VERIFICATION S&T						REMARKS
			SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	S&T TYPE	SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	
SOURCE INSPECTION														
Aggregate (4120.02)	Gradation Quality	AS 209												
Aggregate (Paved Shoulder Fillets) (4120.07)	Gradation Quality	AS 209												
GRADE INSPECTION														
Dimensions	Thickness Width Cross Section	Template	RCE	2/km 2/km 2/km		RCE	Field Book							
Aggregate (Paved Shoulder Fillets)	Gradation	Certification												

AS-Approved Source
ASD-Approved Shop Drawing
S&T-Sampling & Testing

Cert A-Type A Certification
Cert C-Type C Certification
Cert D-Type D Certification

RCE-Resident Construction Engineer/Project Engineer
DME-District Materials Engineer
CTRL-Central Materials Office
CONTR-Contractor

IA-Independent Assurance
V-Verification

October 17, 2006
Supersedes April 15, 2003

SUBDRAINS
Section 2502

Matls. IM 204
Appendix V (US) Units

MATERIAL OR CONSTRUCTION ITEM	TESTS	METHOD OF ACCEPTANCE & RELATED IMs	QUALITY CONTROL					INDEPENDENT ASSURANCE & VERIFICATION S&T						REMARKS
			SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	S&T TYPE	SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	
SOURCE INSPECTION														
Drain Tubing (4143)	Quality	AS 443												
Rodent Guard (4143.01)		AS 443.01												
Subdrain Outlet (4143)		AS												
Porous Backfill (4131)	Quality Gradation	AS 209												
Granular Backfill (4133)	Quality Gradation	AS 209												
Class A (Outlets) (4120.04)	Quality Gradation	AS 209												
GRADE INSPECTION														
Drain Tubing (4143)	Quality	AS												
Engineering Fabric (4196)		AS 496.01												
Subdrain Outlet	Quality	AS Cert D												
Porous Backfill (4131)	Gradation	AS Cert A		Each Shipment										
Granular Backfill (4133)	Gradation	AS Cert A		Each Shipment										
Class A (Outlets) (4120.04)	Gradation	AS Cert A		Each Shipment										
Metal Posts (4154.09)		Visual	RCE											

AS-Approved Source
ASD-Approved Shop Drawing
S&T-Sampling & Testing

Cert A-Type A Certification
Cert C-Type C Certification
Cert D-Type D Certification

RCE-Resident Construction Engineer/Project Engineer
DME-District Materials Engineer
CTRL-Central Materials Office
CONTR-Contractor

IA-Independent Assurance
V-Verification

Sampling & Testing Guide-Minimum Frequency

October 17, 2006
Supersedes April 15, 2003

SUBDRAINS
Section 2502

Matls. IM 204
Appendix V (Metric) Units

MATERIAL OR CONSTRUCTION ITEM	TESTS	METHOD OF ACCEPTANCE & RELATED IMs	QUALITY CONTROL					INDEPENDENT ASSURANCE & VERIFICATION S&T						REMARKS
			SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	S&T TYPE	SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	
SOURCE INSPECTION														
Drain Tubing (4143)	Quality	AS 443												
Rodent Guard (4143.01)		AS 443.01												
Subdrain Outlet (4143)		AS												
Porous Backfill (4131)	Quality Gradation	AS 209												
Granular Backfill (4133)	Quality Gradation	AS 209												
Class A (Outlets) (4120.04)	Quality Gradation	AS 209												
GRADE INSPECTION														
Drain Tubing (4143)	Quality	AS												
Engineering Fabric (4196)		AS 496.01												
Subdrain Outlet	Quality	AS Cert D												
Porous Backfill (4131)	Gradation	AS Cert A		Each Shipment										
Granular Backfill (4133)	Gradation	AS Cert A		Each Shipment										
Class A (Outlets) (4120.04)	Gradation	AS Cert A		Each Shipment										
Metal Posts (4154.09)		Visual	RCE											

AS-Approved Source
ASD-Approved Shop Drawing
S&T-Sampling & Testing

Cert A-Type A Certification
Cert C-Type C Certification
Cert D-Type D Certification

RCE-Resident Construction Engineer/Project Engineer
DME-District Materials Engineer
CTRL-Central Materials Office
CONTR-Contractor

IA-Independent Assurance
V-Verification

Sampling & Testing Guide-Minimum Frequency

WATER POLLUTION CONTROL
EROSION CONTROL

Section 2525, 2601

October 17, 2006
Supersedes April 18, 2006

Matls. IM 204
Appendix W

MATERIAL OR CONSTRUCTION ITEM	TESTS	METHOD OF ACCEPTANCE & RELATED IMs	QUALITY CONTROL					INDEPENDENT ASSURANCE & VERIFICATION S&T						REMARKS
			SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	S&T TYPE	SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	
GRADE INSPECTION														
Seeds 4169.02		Cert A												
Fertilizer 4169.03		AS 469.03												
Inoculants 4169.04		Seed Manufacturer Recommendation												
Sticking Agent		Manufacturer Recommendation												
Sod 4169.07		Visual				RCE	Field Book							
Mulch 4169.07		Visual				RCE	Field Book							
Stakes for Sod		Visual				RCE	Field Book							
Jute mesh 4169.10a		Visual				RCE	Field Book							
Wire Staples 4169.10b		Visual				RCE	Field Book							
Wood Excelsior Mat 4169.10c		Visual				RCE	Field Book							
Engineering Fabrics		AS IM 496.01					Field Book							
Silt Fence Wire and Posts (Std. Rd. Plan RC-16)		Visual				RCE	Field Book							

AS-Approved Source
ASD-Approved Shop Drawing
S&T-Sampling & Testing

Cert A-Type A Certification
Cert C-Type C Certification
Cert D-Type D Certification

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******THIS IS A NEW APPENDIX. – PLEASE READ CAREFULLY.******

ACCEPTANCE OF SMALL QUANTITIES OF MATERIALS

Material	Maximum Quantity	Specifications	Alternate Acceptance Method
Beads, Glass	0.5 mi. application	4184	Visual
Dowel Baskets, Epoxy-coated	25		Visual & Field Check
Fly Ash	5 ton		Approved Source & Type
Hardware for Timber	100 lbs.	4153.07	Visual
Joint Filler, Preformed	50 ft.	4136.03	Visual & Dimension
Lighting Material-Conduit & Fittings	100 ft	4185.10	Visual & Brand Name
Paint, Bridge	5 gal.	4182	Visual & Brand Name
Pipe, Welded Steel for Bridge Railing	100 ft.	4153.05	Letter of Compliance

SUPPLEMENTAL GUIDE – BASIS OF ACCEPTANCE

Material	IM	Spec.	Sample Size	Sampled By	Basis of Acceptance	Cert. Type	Verification	Other Details
Abrasives for Blast Cleaning	482.03				Approved Source			Note brand in field book
Admixture-Air Entraining	403	4103	1 pt.	DME or RCE	Approved Source Batch (Lot)		Project	Contact District Matls.
Admixture-Corrosion Inhibitor	402	4103	1 pt.	DME or RCE	Approved Source Batch (Lot)		Project	Contact District Matls.
Admixture-Retarder	403	4103	1 pt.	DME or RCE	Approved Source Batch (Lot)		Project	Contact District Matls.
Admixture-Water Reducer	403	4103	1 pt.	DME or RCE	Approved Source Batch (Lot)		Project	Contact District Matls.
Aggregates-Non-proportioned	209	4110-4133			Approved Source/Certified Truck Tickets, (Form #821278)	D	Source	Certified Ticket for pay items by weight
Aggregates-Proportioned	209 & 204	4110-4133	IM 301	CONTR/RCE/ DME	Approved Source/Certified Truck Tickets, (Form #821278)	D	Source Project	
Aluminum, Structural		4190.01			Approved Shop Drawing & Fabrication Report			
Anchor Bolts	453.08	2522.04, D 4185.02, A 4187.01, C	1 bolt, nut & washer per size, per project	DME	Approved Source/Test Report/Steel Mill Certifications	A		
Anchors, Concrete	453.09				Approved Source			
Anti-Strip Agent	491.16				Approved Source			
Arrow Panels, Solar-Assisted	486.12	2528.06			Approved Source			
Asphalt Binder	437	4137	1 4-oz. tin	CONTR/DME	Approved Source/Certification/Test Rpt.	D	Source Project	
Asphalt, Cutback	437	4138	1 qt. tin	RCE	Approved Source/Certification/Test Rpt.	D	Source	

SUPPLEMENTAL GUIDE – BASIS OF ACCEPTANCE

Material	IM	Spec.	Sample Size	Sampled By	Basis of Acceptance	Cert. Type	Verification	Other Details
Asphalt, Emulsified	437	4140	1 qt. bottle	RCE	Approved Source/Certification/Test Rpt.	D	Source	Project verification for seal coat
Attenuators -see crash cushion								
Attenuators, Guardrail					As per plan			
Backer Rod for Cold Pour Joint Seal	436.04	4136.02, C			Approved Source			
Backer Rod for Hot Pour Joint Seal	436.04	4136.02C			Approved Source			
Barrier Rail, Precast Concrete	571	2513			Approved Source/DOT Stamp/Fabrication Report		Source	
Beads, Glass	484	4184	1 qt.	DME	Approved Source		Subcontr.	
Bearing, Bronze		4190.03	1/project	DME	Test Report			
Bearing, Lead		4195.01			Certification	D		
Bearing, Neoprene	495.03	4195.02	1/pad	DME	Fabrication Report/Approved Source		Fabricator	
Bentonite Clay					Visual Approval by RCE			
Bolts, Nuts & Washers, Structural	453.06B	4153.06	Per IM 453.06B	DME	Certification/Rotational Capacity Test/Test Report	A		
Calcium Chloride Solution	373	4194.01	4 lbs. or 1 qt.	RCE	Test by RCE			
Caulking Compound		4192			Visual Approval by RCE			
Concrete, Special Sections	445	4145 4149.02, B			Approved Source, Fabricator's trade mark, Date of Manufacture, Certified stamp,Certification	D	Source	

Material	IM	Spec.	Sample Size	Sampled By	Basis of Acceptance	Cert. Type	Verification	Other Details
Concrete, Modular & Segmental Block	445.04				Approved Source/Certification	D		
Concrete, Precast Box Culvert	445.02	2415			Approved source, Approved Shop Drawing, Fabricator's trade mark, Date of Manufacture, Certified stamp, Certification	D	Source	
Concrete, Prestressed, Precast Units	570	2407			Approved Source, Fabricator's trade mark, Date of Manufacture, Certified stamp, Fabrication Report		Source	
Concrete Sealer	491.12	4139			Approved Source			
Conduit – See Lighting Matl.								
Curing Matls., Burlap		4104			Visual Approval by RCE			
Curing Matls., Clear	405.07	4105.07			Approved Source			
Curing Matls., Dark-colored	437	4105.06			Approved Source		Source	
Curing Matls., Plastic Film		4106.02			Visual Approval by RCE			
Curing Matls., White Pigmented	405	4105.05	1 qt.	DME	Batch (Lot) Accept		Source	
Crash Cushion	455	2509			Approved Source, Certification if source not clearly marked	D		
Delineators–See Signing Matls.								
Detectable Warning Panels	411	2511.02			Approved Source			
Dowel-See Steel Reinforcement								

Material	IM	Spec.	Sample Size	Sampled By	Basis of Acceptance	Cert. Type	Verification	Other Details
Drainage Trough, Elastomeric Bridge Joints	494				Approved Source			
Drains, Floor		2406.05			Approved Shop Drawing & Fabrication Report			
Drums, Channelizing	488.02	4188.02			Approved Source			
Epoxy-coated Steel-See Steel Reinforcement								
Epoxy Injection Resin	491.19				Approved Source			
Erosion Control, Fertilizer	469.03	4169.03			Approved Source			If material is suspect, DME will sample
Erosion Control, Fungicide		4169.05			Seed Manufacturing Recommendation			
Erosion Control, Inoculant		4169.04			Seed Manufacturing Recommendation			
Erosion Control, Jute Mesh		4169.10, A			Visual Approval by RCE			
Erosion Control, Mulch		4169.08			Visual Approval by RCE			
Erosion Control, Seed	469.02	4169.02			Certification	A		
Erosion Control, Silt Fence Fabric	496.01	4196.01			Approved Source			
Erosion Control, Silt Fence Wire & Posts		Std. Road Plan RC-16 Series			Visual Approval by RCE			
Erosion Control, Sod		4169.07			Visual Approval by RCE			
Erosion Control, Sod Stakes		4169.09			Visual Approval by RCE			

SUPPLEMENTAL GUIDE – BASIS OF ACCEPTANCE

Material	IM	Spec.	Sample Size	Sampled By	Basis of Acceptance	Cert. Type	Verification	Other Details
Erosion Control, Sticking Agent		4169.06			Seed Manufacturing Recommendation			
Erosion Control, Wire Staples		4169.10, B			Visual Approval by RCE			
Erosion Control, Wood Excelsior Mat	469.10				Approved Source			
Expansion Device, Steel		4152.02			Approved Shop Drawing & Fabrication Report			
Expansion Tube		4191.01, B			Visual Approval by RCE			
Fabric Engineering	496.01	4196.01			Approved Source			
Fasteners, Aluminum Structural	486	4190.02			Fabrication Report			
Fence, Barbed Wire		4154.04			Visual Approval by RCE			
Fence, Brace for Field Fence		4154.08			Visual Approval by RCE			
Fence, Tie & Tension Wire		4154.05			Visual Approval by RCE			
Fence, Chain Link Fabric	454.10	4154.03	1/source/yr		Approved Source/Certification		Project	
Fence, Chain Link Fittings		4154.11			Visual Approval by RCE			
Fence, Chain Link Posts, Braces, & Rails	454.10	4154.10	1/source/yr		Approved Source/Certification		Project	
Fence, Field Fence Fabric		4154.02			Visual Approval by RCE			
Fence, Gate		4154.12			Visual Approval by RCE			
Fence, Misc. Hardware					Visual Approval by RCE			

Material	IM	Spec.	Sample Size	Sampled By	Basis of Acceptance	Cert. Type	Verification	Other Details
Fence, Orange Mesh Safety	488.03	4188.03			Approved Source			
Fence, Silt-See Erosion Control								
Fence, Staples		4154.06			Visual Approval by RCE			
Fence, Steel Line Posts		4154.09			Visual Approval by RCE			
Fence, Wood Fence Post	462	4154.07			Approved Source/Certification	D		
Fertilizer-See Erosion Control								
Fly Ash	491.17	4108	10 lbs.	DME	Approved Source/Certification	D	Project Source	Verification on paving only
Galvanized Items		4100.07		DME	Test Report by District Materials			
GGBFS	491.14	4100.08			Approved Source/Certification	D	Source Project	
Grating (Aluminum)		4187.01, A			Approved Shop Drawing & Fabrication Report			
Grout, Hydraulic Cement	491.13				Approved Source			
Grout, Polymer	491.11				Approved Source			
Guardrail, Box-beam Median Barrier		4155.06			Approved Shop Drawing & Fabrication Report			
Guardrail, Cable		4155.06	6 ft.	DME	Test Report by Central Lab			
Guardrail, High Tension Cable	455.01	SS-01048			Approved Source/Certification	D		
Guardrail, Formed Steel Beam	455.02	4155.02			Approved Source			

SUPPLEMENTAL GUIDE – BASIS OF ACCEPTANCE

Material	IM	Spec.	Sample Size	Sampled By	Basis of Acceptance	Cert. Type	Verification	Other Details
Guardrail, Steel Posts		4155.05			Mill Test Report	A		
Guardrail, Wood Posts	462	4155.04			Approved Source/Certification	A		
Iron Castings, Utility Access Covers, etc.	453.04	4153.04			Certification & Proper Identification Imprint	A		
Iron Castings, Utility Access Adjustment Rings	449.05				Approved Source/Certification	D		
Iron Bridge Rockers		4153.04			Approved Shop Drawing & Fabrication Report			
Joint Filler, Flexible Foam-Type CF & EF Joints	436.05	4136.03, B 4136.03, D			Approved Source			
Joint Filler, Type E Joint	436.03	4136.03, A			Approved Source			
Joint Filler, Bituminous	436.03	4136.03, A			Approved Source			
Joint Sealer for Concrete Sewer Pipes	491.09	4149.08			Approved Source			
Joint Sealer, Elastomeric (Neoprene)	436.02	4136.03			Approved Source			
Joint Sealer, Poured	436.01	4136.02, A			Approved Source			
Keyway		4191.01, A			Visual Approval by RCE			
Lighting Material, Aluminum Poles	557	4185.02, E			Approved Shop Drawing/Approved Source/Certification	D		
Lighting Material, Circuit Test		2523.21		Contractor	Test Report (Contractor) Form #820928			
Lighting Material, Connectors		4185.11			Approved Catalog Cut			
Lighting Material, Contactors		4185.05			Approved Catalog Cut			

Material	IM	Spec.	Sample Size	Sampled By	Basis of Acceptance	Cert. Type	Verification	Other Details
Lighting Material, Control Cabinet		4185.07			Approved Shop Drawing & Catalog Cut			
Lighting Material, Conduit & Fittings, Plastic		4185.10	4'-Plastic	DME	Test Report			
Lighting Material, Conduit & Fittings, Steel	485.10	4185.10			Approved Source			
Lighting Material, Ground Rods & Clamps		4185.04			Visual			
Lighting Material, Handholes	445	4185.08			Approved Source, Fabricator's trade mark, Date of Manufacture, Certified stamp, Certification	D	Source	
Lighting Material, Junction Boxes		4185.09			Approved Catalog Cut			
Lighting Material, Lighting Tower	557	2522.04			Approved Shop Drawing/Approved Source/Certification	D		
Lighting Material, Lowering Device		2522.06			Approved Shop Drawing & Fabrication Report			
Lighting Material, Luminaries		4185.03			Approved Catalog Cut			
Lighting Material, Photoelectric Control		4185.06			Approved Catalog Cut			
Lighting Material, Sealant for Traffic Loop Detectors	491.18				Approved Source			
Lighting Material, Steel Poles	557	4185.02, D			Approved Shop Drawing/Approved Source/Certification	D		

Material	IM	Spec.	Sample Size	Sampled By	Basis of Acceptance	Cert. Type	Verification	Other Details
Lighting Material, Underground Warning Tape		2523.13			Visual Approval by RCE			
Lighting Material, Wire & Cable		4185.12			Approved Catalog Cut & Certification	D		DME may obtain verification samples
Lighting Material, Wood Poles	462	4185.02, F			Approved Source/Certification	D		
Lighting Material, Fasteners for Poles	453.09	4185.02, A	1 each type	DME	Test Report & Approved Shop Drawing			
Lighting Material, Mastarms	557	4185.02, B			Approved Shop Drawing/Approved Source/Certification	D		
Lighting Material, Slip Base	557	4185.02			Approved Shop Drawing/Approved Source/Certification	D		
Lighting Material, Transformer Base	557	4185.02, C			Approved Shop Drawing/Approved Source/Certification	D		
Markers (reflective) for Guardrail & Concrete Barrier Rail	486.08	4186.08			Approved Source			
Markers, Raised Pavement	483.07	2527.02, E			Approved Source			
Mastarms-See Lighting Materials								
Paint, Epoxy Aluminum	482.04				Approved Source			
Paint, Traffic-VOC-Compliant Solvent-borne	483.03	4183.03			Approved Source			
Paint, Traffic Waterborne	483.03	4183.04			Approved Source		Subcontr.	

Material	IM	Spec.	Sample Size	Sampled By	Basis of Acceptance	Cert. Type	Verification	Other Details
Paint, Waterborne Acrylic Finish (Bridge Paint)	482.05	4182.03			Approved Source/Certification	D		
Paint, Zinc-rich Epoxy	482.02	4182.02			Approved Source/Certification	D		
Paint, Zinc-silicate Solvent-borne	482.05	4182.02			Approved Source/Certification	D		
Patch Material, Rapid-set Concrete	491.20				Approved Source			
Pedestrian Bridge, Pre-engineered	557				Approved Source/Approved Shop Drawing			
Piling, Concrete	570	4166			Approved Source, Fabricator's trade mark, Date of Manufacture, Certified stamp, Fabrication Report		Source	
Piling, Steel	467	4167			Approved Source/Mill Certification	A	Project	
Pipe, ABS Sewer/PVC	443, 446	4146.04 4146.05			Approved Source/Certification	D	Source	
Pipe, Clay Sewer		4149.02, A	2 each	DME	Test Report			
Pipe, Concrete	445	4145			Approved Fabricator, Fabricator's trade mark, Date of Manufacture, Certified stamp, Certification	D	Source	
Pipe, Corrugated Aluminized	441	4141			Approved Source/Certification			
Pipe, Corrugated Polyethylene 3-10 in.	443	4146.02 4143.02			Approved Source		Source	
Pipe, Corrugated Polyethylene 12-36 in.	446	4146.02			Approved Source/Certification	D	Source	

Material	IM	Spec.	Sample Size	Sampled By	Basis of Acceptance	Cert. Type	Verification	Other Details
Pipe, Corrugated Steel	441	4141			Approved Source/Certification	D	Fabricator	
Pipe, Ductile Iron Sewer		4149.02, C			Certification	A		
Pipe, Polyethylene Sewer	443, 446	4146.03			Approved Source/Certification	D	Source	
Pipe, Rodent Guard for PE Pipe	443.01	4143.01, B			Approved Source			
Pipe, Rodent Guard for CMP Pipe	443.01	4143.01, B			Approved Source			
Pipe, Concrete Subdrain Tile	448	4148			Approved Source/Certification	C	Source	
Pipe, Corrugated Metal Subdrain Outlet	441	4141			Approved Source/Certification	D	Fabricator	
Pipe, Corrugated Polyethylene Subdrain	443	4143.01, B			Approved Source		Source	
Pipe, Welded Steel for Bridge Rail (See Railing, Bridge)								
Pipe, Horizontal Subdrain	443	4143.01, A			Approved Source		Source	
Plant Material, Fertilizer	469.03	4170.09, B			Approved Source			
Plant Material, Mulch	470	4170.09, D		RCE	Field Review Report			
Plant Materials, Plants	470	4170.01-4170.08		Roadside Development	Field Review Report			Rpt. Issued-Roadside Development
Portland Cement Concrete Premix Pack	447				Approved Source/Certification	C	Source	
Portland Cement, All Types	401	4101	10 lbs.	DME	Approved Source/Certification	D	Project Source	

SUPPLEMENTAL GUIDE – BASIS OF ACCEPTANCE

Material	IM	Spec.	Sample Size	Sampled By	Basis of Acceptance	Cert. Type	Verification	Other Details
Railing, Bridge		4153.05			Approved Source/Approved Shop Drawing/Fabrication Report			
Reflective Sheeting-See Signing Material								
Release Agent	491.15				Approved Source			
Sealant, Traffic Loop-See Lighting Material								
Seed-See Erosion Control								
Signing Material, Delineator Posts		4186.10, C	1 each supplier	DME	Test Report			
Signing Material, Delineators	486.07	4186.07			Approved Source		Project	
Signing Material, Finished Sign	486	4186			Fabrication Report/Approved Source/Certification	D	Source	
Signing Material, Fasteners		4186.06			Fabrication Report			
Signing Material, Reflective	486.03	4186.03			Approved Source		Source	
Signing Material, Sign Panels		4186.02			Approved Shop Drawing & Fabrication Report			
Signing Material, Sign Support Structures	557	4187			Approved Source/Approved Shop Drawing/Fabrication Report			
Signing Material, Stainless Steel Fasteners	453.07		1 per size per proj.	DME	Approved Source/Mill Certification	A	Project	
Signing Material, Steel Posts		4186.10			Approved Shop Drawing & Fabrication Report			

SUPPLEMENTAL GUIDE – BASIS OF ACCEPTANCE

Material	IM	Spec.	Sample Size	Sampled By	Basis of Acceptance	Cert. Type	Verification	Other Details
Signing Material, Wood Posts	462	4186.10			Approved Source/Certification	A		
Signing Material, Galvanized Items		4100.07			Test Report by District Materials			
Sod-See Erosion Control								
Steel Castings		4153.03			Approved Source/Catalog Cut			
Steel Masonry Plates		4152.02			Mill Certification	A		
Steel Pile, Welded		4153.05			Approved Shop Drawing & Fabrication Report			
Steel, Pins/Rollers, Cold Finished		4153.02			Approved Source/Catalog Cut			
Steel, Pins/Rollers, Forged		4153.01			Approved Source/Catalog Cut			
Steel Reinforcement, Basket Assemblies	451.03B	4151.02			Approved Source/Certification	D		
Steel Reinforcement, Epoxy-coated	451.03B	4151.03, B	6 ft.	DME	Approved Source/Mill Certifications & Epoxy Certification/Test Report	A	Project	Test sample should be 3 ft. away from end of the bar.
Steel Reinforcement, Epoxy-coated Tie Bars	451.03B	4151.02, A	1 per project per year		Approved Source/Certification	D	Project	
Steel Reinforcement, Epoxy-coated Dowels	451.03B	4151.02	1 per project per year		Approved Source/Certification	D	Project	
Steel Reinforcement, Galvanized	451	4151.03, A	3 ft.	DME	Mill Certifications & Test Report for Galvanizing	A	Project	
Steel Reinforcement, Uncoated	451	4151	*6 ft. of most common	DME	Approved Source/Mill Certification	A	Project	*Proj. quant. under 45T Cert. Only, 45T+ 1 samp.

Material	IM	Spec.	Sample Size	Sampled By	Basis of Acceptance	Cert. Type	Verification	Other Details
Steel Reinforcement, Wire Mesh	451	4151.04	2 ft. x 2 ft.	DME	Approved Supplier or Distributor. Steel Reinforcement/Certification	A	Supplier	1 sample per source per year
Steel Mechanical Splicers for Reinforcement	451				Approved Source/Mill Certification/Epoxy Certification		Project	Need: Certification Statement, Project #, Quantity, Heat #
Steel Structural	557, 561 to 565	2408 4152			Approved Source/Approved Shop Drawing/Fabrication Report/Mill Certifications	A		
Step Irons for Utility Access		4149.06			Fabrication Report			
Structural Items, Other					Approved Shop Drawing & Fabrication Report			
Structural Plate (Arches)	444	4144	Visual	RCE	Approved Source/Certification Statement	C		
Studs, Shear	453.10				Approved Source/Certification	A		
Surface Finish, Special	491.10	2403.21, C			Approved Source			
Tape, Pavement Marking	483.06	2527.02, A			Approved Source			
Torque Calibration Machine (skidmore)		2408.38, C	Calibrate every 6 mo.	CTRL	Test Report			
Torque Wrench		2408.38, C	Calibrate every 6 mo.	CTRL	Test Report			
Traffic Signalization, Electrical Tests		2525.03, A, 3b 2525.06, A		Contractor	Test Report (Contractor) Form #820928			
Water		4102	1 qt. per source	DME	Test Report or City Water Supply			

Material	IM	Spec.	Sample Size	Sampled By	Basis of Acceptance	Cert. Type	Verification	Other Details
Wire & Cable-See Lighting Material								
Wood, Hardware for Timber Structure	462	4153.07	1 ea. type		Test Report			
Wood, Timber Piles	462	4165			Approved Source/Certification	A		Charge number on butt ends
Wood, Treated Posts	462	4164			Approved Source/Certification	A		
Wood, Treated Timber & Lumber	462	4162			Approved Source/Certification	A		
Wood, Untreated Timber & Lumber	462	4162	Visual	RCE	Quality grad mark or certification of grade on items requiring grade			

Iowa Department of Transportation

Office of Materials

October 17, 2006
Supersedes October 19, 2004

Matls. IM 208

MATERIALS LABORATORY QUALIFICATION PROGRAM

GENERAL

The FHWA has outlined a Laboratory Qualification Program in the Federal-Aid Policy Guide update published as 23 CFR 637 on June 29, 1995. The updated guide has requirements for laboratories performing testing on Federal-Aid highway projects.

In order to avoid an appearance of a conflict of interest, any qualified non-DOT laboratory shall perform only one of the following types of testing on the same project: Verification testing, quality control testing, IA testing, or dispute resolution testing.

LABORATORIES TO BE QUALIFIED

The following laboratories are included in the qualification program for all Federal-Aid projects:

Central Materials Laboratory
6 District Laboratories
District Area Laboratories
Resident Construction Laboratories*
Aggregate Producer Laboratories
Ready Mix Laboratories
PCC Contractor Laboratories
HMA Contractor Laboratories
Consultant and Commercial Laboratories *
City and County Laboratories *

* May be qualified at the time of a project.

LABORATORY QUALIFICATION PROCESS

A two-level qualification system is required by the FHWA. Laboratories are either accredited or qualified. The accreditation process is more rigorous than the qualification process.

Accredited Laboratory Process

The Central Materials Laboratory and the six District Laboratories will be accredited as outlined in the 23 CFR 637 guide. The Central Materials Laboratory is accredited through the AASHTO Materials Reference Laboratory Program. The District Materials Laboratories will be accredited by using the Central Materials Staff and equipment to check testing and testing procedures and by using the same calibration and training documentation process. Laboratories will be accredited for a two-year period. In addition, an annual review will be made by the Central Office Staff. Appendix A contains the procedures for accrediting the District Materials Laboratories.

Qualified Laboratory Process

The remaining laboratories will be qualified as outlined below:

The District Materials Offices will qualify laboratories. Laboratories will be qualified for a two-year period. In addition, an annual review will be made by District Staff. Appendix B contains the procedures for qualifying materials laboratories.

Three laboratory types will be qualified, aggregate laboratories, PC Concrete laboratories and Hot Mix Asphalt laboratories.

Qualified laboratories will have the following:

1. Current manuals and test methods to perform the qualified testing available
2. A technician certified by the Iowa DOT to perform the qualified testing
3. Proper equipment to perform the qualified testing (calibrated or checked annually according to Appendix B)
4. Satisfactory project and proficiency test results
5. Documentation of equipment calibrations, equipment checks, and proficiency results

ADMINISTRATION OF THE PROCESS

The Central Materials Laboratory will be responsible for implementation and operation of the Laboratory Qualification Program. The Central Materials Laboratory will accredit the District Laboratories. The District Materials Offices will qualify laboratories.

NON-COMPLIANCE/DISPUTE RESOLUTION

A laboratory that does not meet the requirements of the IM is subject to elimination from the qualification program.

Disputes concerning calibration and correlation of equipment will be resolved by the office responsible for the qualification. For disputes that cannot be resolved at the District, the Central Materials Laboratory will be the final authority.

DISTRICT LABORATORY ACCREDITATION PROGRAM

The Central Materials Laboratory (CML) will accredit the District Materials Laboratories and maintain records of the accreditation for five years. The CML Staff will check the following prior to accrediting a laboratory:

1. Check for current manuals and test procedures covering the accredited testing.
2. Check the certification and training records of the testing personnel.
3. Document that proper equipment is available to perform qualified testing.
4. Check documentation system.

Scheduling of the annual accreditation review will be discussed with the laboratories needing accreditation.

Table 1 is the list of items to be reviewed.

An oral close out on any deficiencies will be held with the testing personnel. Written notice will be sent within two months of the inspection. CML personnel will re-inspect if necessary after correction of any deficiencies.

A report showing the laboratory, the date accredited, and the expiration date will be issued by the Materials Testing Engineer.

NON-COMPLIANCE/DISPUTE RESOLUTION

A laboratory that does not meet the requirements of the IM is subject to elimination from the qualification program.

The CML and the District Materials Engineer will resolve disputes concerning calibration and correlation of equipment.

TABLE 1 - Laboratory Accreditation Checklist

	√	Minimum Calib./Verif. Interval	Calib./Verif. Procedure
Tester Qualifications-Proper Iowa DOT certifications			
Current Test Procedures			
Current Calibration Procedures & Records			
Documentation of correlation results and corrective actions taken for previous construction season			
Balances		12 months	Iowa 917-B
Ovens		12 months	Iowa 1501-A
Mechanical Shakers		12 months	Iowa 1502-A
Marshall Compactor T-245		12 months	Iowa 1504-A
Gyratory Compactor T-312		6 months	Iowa 1522-A
Marshall Molds T-245		12 months	Iowa 1523-A
Comp. Test Machine T-245		12 months	Iowa 1505-A
Sieves		6 months	Iowa 1506-A
Thermometers - Test		6 months	Iowa 1607-A
Thermometers - Ref.		12 months	Iowa 1607-A
Timers T-201, T-202		6 months	Iowa 1508-A
Sand Equivalent T-176		12 months	Iowa 1509-A
Gyratory Compactor Molds T-312		12 months	Iowa 1524-A
Vacuum Systems T-209		12 months	Iowa 1510-A
Pycnometers T-228, T209		12 months	Iowa 1618-A
Fine Aggregate Anularity T-304		12 months	Iowa 1525-A
Dynamic Shear Rheometer T-315		6 months	Iowa 1612-A
Balance Weights M-231		12 months	
Sample Splitters T-248		12 months	(visual condition)

LABORATORY QUALIFICATION PROGRAM

The District Materials Office will qualify the other laboratories and maintain records of the qualification for three years. The District Staff will check the following prior to qualifying a laboratory:

1. Establish the type of laboratory (Aggregate, Hot Mix Asphalt, PC Concrete).
2. Check for current manuals and test procedures covering the qualified testing.
3. Check the certification of the testing personnel.
4. Document that proper equipment is available to perform qualified testing.
5. Check documentation system.

Scheduling of the qualification review will be discussed with the laboratories seeking qualification. The District Materials Engineer should be contacted for laboratories that have been qualified in other states. The District Materials Office may qualify a laboratory based on an acceptable qualification report and qualification program from another state transportation agency.

Table 1 and the pages following cover the list of items to be reviewed.

An oral close out on any deficiencies will be held with the testing personnel. Written notice will be sent within two weeks of the inspection. District personnel will re-inspect after correction of any deficiencies.

A form showing the laboratory type, the date qualified, and the expiration date will be issued by the District Materials Engineer.

The list of Qualified Laboratories will be maintained on a database accessible by authorized Materials Personnel.

NON-COMPLIANCE/DISPUTE RESOLUTION

A laboratory that does not meet the requirements of the IM is subject to elimination from the qualification program.

The office responsible for the qualification will resolve disputes concerning calibration and correlation of equipment. For disputes that cannot be resolved at the District level, the Central Materials Laboratory will be the final authority.

Table 1 - Laboratory Qualification Checklist

	√	Calib./Verif. Interval	Calib./Verif. Procedure
Tester Qualifications-Proper Iowa DOT certifications			
Current Test Procedures			
Current Calibration Procedures & Records			
Documentation of correlation results and corrective actions taken for previous construction season.			
Aggregate Laboratory			
Balances		12 months	Iowa 917-B
Sieves- wear, tear, size, and opening size		12 months	Iowa 1506-A
Splitter- condition		12 months	(Visual)
Mechanical Shakers- condition (if used)		12 months	Iowa 1502-A
HMA Laboratory			
Balances- and water bath		12 months	Iowa 917-B
Sieves- wear, tear, size, and opening size		12 months	Iowa 1506-A
Splitter- condition		12 months	(Visual)
Mechanical Shakers- condition (if used)		12 months	Iowa 1502-A
Rice equipment- vacuum and flask		12 months	IM 350
Thermometers		12 months	Iowa 1607-A
Ovens- temperatures		12 months	Iowa 1501-A
Gyratory Compactor and molds		12 months	Iowa 1524-A
Marshall Hammer and molds		12 months	Correlation Checks
PCC Laboratory			
Balances		12 months	Iowa 917-B
Sieves- wear, tear, size, and opening size		12 months	Iowa 1506-A
Splitter- condition		12 months	(Visual)
Mechanical Shakers- condition (if used)		12 months	Iowa 1502-A
Air Meter		12 months	IM 318
Slump Cone and equipment-condition		12 months	
Beam Breaker		12 months	Central Lab

LABORATORY ITEMS

The following list contains, as a minimum, what is required for a qualified asphalt laboratory. The test equipment to perform each of the required tests is contained in the respective IM.

- Field Lab and Office [Suggested size 8 ft. x 44 ft. (2.4 m x 13.41 m)]. Locate the Field Lab so it is convenient to the plant, but outside the influence of plant vibration.

  Air-conditioned
  Personal computer
  Phone
  Fax machine
  Copy Machine
  Sample storage
  Work table
  Bulletin board
  Water available to perform necessary testing
  Desk and chair
  Incidental spoon, trowels, pans, pails

- The personal computer shall be capable of running Iowa DOT programs. It is recommended to have at least Windows 2000 or newer software on the computer. Iowa DOT programs have been checked and are capable of running on Windows 2000 and newer software.

  3.5" high-density floppy disk drive (CD drive recommended)
  Color monitor, VGA or better
  Printer, ink jet recommended.

- Diamond saw for cutting core lifts.

- Diamond core drill (minimum 4" diameter core).

Iowa Department of Transportation

MATERIALS LABORATORY QUALIFICATION PROGRAM

Laboratory Inspection - per Materials Instructional Memorandum 208

Company Name: ______________________________

Laboratory name: ______________________________

Laboratory type: Aggregate HMA PCC (Circle one)

Laboratory location: ______________________________

Laboratory contact person: ______________________________

Laboratory technician:	Certification number:	Expires:
______________	______________	________
______________	______________	________
______________	______________	________

Current manuals and written test procedures available? ______________________________

Current calibration procedures and records? ______________________________

____

Documentation of correlation results and corrective actions taken for previous construction season? ________

____

____

Proper equipment available to perform qualified testing? ______________________________

____

Other remarks: ______________________________

____

Date of inspection: ______________ Qualification expiration date: ______________

Inspection performed by: ______________________________
Print name

____
Sign name

Inspection received by: ______________________________
Print name

____
Sign name

District Number ____________

cc: Materials Engineer, Contractor/Producer, Ames, File

Iowa Department of Transportation

AGGREGATE LABORATORY INSPECTION QUALITY CONTROL CHECKLIST

Contractor/Producer: ____________________ Location: ______________

Certified Technician: ____________________ Certification No: __________

		Yes	No
Balances	(Iowa Test Method 917-B)		
	Updated balance calibration records available?	______	______
	Check balance using 500 gm & 1000 gm calibrated weights?	______	______
	Is balance accurate to 0.1%?	______	______
Sieves			
	Is there adequate correlation history to qualify?	______	______
	Were go/no-go gauges used to check accuracy?	______	______
	Are the sieves in good condition (no loose frames, holes, or tears)?	______	______
Splitter			
	Is the splitter in good condition? (i.e., missing shuts, cracked welds, or leaking seams)	______	______
Shaker			
	Is shaker apparatus secure and level?	______	______
Scale			
	Are the laboratory weights used for routine calibrations accurate? (Use 0.1% difference from our calibrated weights as standard.)	______	______

Comments ____

____

____

____

cc:Materials Engineer
Contractor/Producer
Ames
File

Inspected By: ____________________

Date Inspected: ____________________

Iowa Department of Transportation

HMA LABORATORY INSPECTION
QUALITY CONTROL CHECKLIST

Contractor/Producer: ____________________ Location: ____________________

Certified Technician: ____________________ Certification No.: ____________________

	Yes	No
Thermometers (IM 321, IM 325, IM 325G, IM 350)		
Thermometer Calibration and Documentation available?	_____	_____

Temperature of check: ____________ (25 deg C or 135 deg C)
State reference thermometer ____________
Contractor reference thermometer ____________
Difference ____________

	Yes	No
Rice Pycnometer (IM 350)		
Calibration chart and/or documentation available?	_____	_____
Equipment achieves between 25.5 and 30mm of mercury vacuum?	_____	_____
Mercury is free of bubbles?	_____	_____
Gyratory/Marshall Compactor (IM 325/IM 325G)		
Calibration documentation available?	_____	_____
Is equipment generally clean?	_____	_____
Documentation of annual mold measurements?	_____	_____
Ovens (IM 325/IM 325G)		
Documentation of temperature checks?	_____	_____
General condition satisfactory?	_____	_____
Do all parts work as intended?	_____	_____

Water Bath (IM 321)

Temperature? ____________

	Yes	No
Correlation		
Correlation results available for previous year?	_____	_____

Comments: ____

____

____

____

NOTE: HMA labs must also qualify as an aggregate lab.

cc: Materials Engineer
Contractor/Producer
Ames
File

Inspected By: ____________________

Date Inspected: ____________________

Iowa Department of Transportation

READY MIX/PCC PAVING LABS
QUALITY CONTROL CHECKLIST

Contractor/Producer: ____________________ Location: ____________

Certified Technician: ____________________ Certification No: ________

Inspection Checklist Items:

	Yes	No
Air Meter (IM 318)		
Check meter using approved 5% pugs.	____	____
Is air meter clean?	____	____
Proper rod and mallet.	____	____
Slump Cone (IM 317)		
Interior of cone free of dents or projections.	____	____
5/8" by 24" tamping rod.	____	____
Rigid, nonabsorbent base.	____	____
Equipment clean and free of hardened concrete.	____	____
Beam Breaker (IM 316)		
Current annual calibration sheet	____	____
Equipment clean.	____	____
Beam Molds (IM 328)		
Molds clean and free of dents	____	____
General condition of molds good.	____	____

Comments ____

NOTE: PCC labs must also qualify as an aggregate lab.

cc: Materials Engineer
Contractor/Producer
Ames
File

Inspected By: ____________________

Date Inspected: ____________________

INDEPENDENT ASSURANCE PROFICIENCY & TESTING FOR HMA

GENERAL

The HMA Proficiency Program is part of the Independent Assurance Program described in IM 205. The HMA Proficiency Program provides participating laboratories with a means to:

- Check both the instrument and the operator under actual testing conditions.
- Compare individual test results with the average of a large body of results so that corrective action may be taken where wide discrepancies occur.
- Evaluate the quality of test results, thereby reducing the risk of dispute due to testing errors.

Each accredited and qualified Laboratory and certified staff shall establish and maintain their proficiency by following program described herein.

A project approach for independent assurance may be used for RCE, county, city, and consultant laboratories.

PROFICIENCY SAMPLE

The Central Materials Laboratory will prepare and send out proficiency samples during the construction season (April through September). The samples and tests for laboratories will be as follows:

A. District Laboratories

1. Asphalt Binder
    a. G*/Sin Delta
2. HMA Mix
    a. G_{mb} Laboratory Density
    b. G_{mm} Maximum Specific Gravity
    c. % Binder, Ignition Oven
    d. Gradation, Ignition Oven
3. Combined Aggregate
    a. Gradation
    b. G_{sa} Apparent Specific Gravity (every other sample)

- c. G_{sb} Bulk Specific Gravity (every other sample)
- d. Percent Absorption (every other sample)
- e. Fine Aggregate Angularity (every other sample)
- f. Sand Equivalency (every other sample)

B. HMA Laboratories

1. HMA Mix
   - a. G_{mb} Laboratory Density
   - b. G_{mm} Maximum Specific Gravity
2. Combined aggregate
   - a. Gradation

C. Aggregate Laboratories

1. Gradation

PROFICIENCY SAMPLE FREQUENCY

District Laboratories will receive a set of proficiency samples monthly April through September. The samples will be tested and the results reported within 14 calendar days of receipt.

HMA laboratories and HMA aggregate laboratories will pick-up proficiency samples one to three times per year depending on how many projects are done in a particular year. The frequency criteria is as follows:

- A sample shall be picked up for the technician's first HMA project of the construction season.
- At 3 months from the first sample pickup, the technician must pick up a second sample in order to continue performing acceptance testing.
- At 3 months from the second sample pickup, the technician must pick up a third sample in order to continue performing acceptance testing.

Each certified technician routinely working in the laboratory shall perform the proficiency tests and report the results within 14 calendar days of receipt.

TEST RESULT ANALYSIS

Test results from the proficiency samples will be analyzed using the current AASHTO Material Reference Laboratory (AMRL) procedure. The analysis compares the results from each participant and each District and Central Laboratory to the overall mean. Test results will also be compared to the Central Materials Laboratory results.

Any test result that is 3.0 standard deviations or greater from the mean will be considered failing. Two consecutive proficiency sample results that are 2.0 standard deviations or greater from the mean will be considered failing.

In the event of a small data set or large or small variation within a data set, the individual results will be compared with the Central Laboratory results. IM 216 will be used to compare the results. Proficiency test results beyond the tolerance will be considered failing.

INVESTIGATION OF FAILING TEST RESULTS

The technician with failing test results shall review the calculation, test procedures, and perform a calibration if warranted. When there are two or more consecutive failing results, the Central Materials Laboratory or the District Material Engineer will contact the technician and arrange to conduct an evaluation of the procedures and equipment to correct any deficiencies. More than 3 consecutive failing results by a technician will constitute unsatisfactory performance as defined in IM 213 and become a part of their permanent file.

Iowa Department of Transportation

Office of Materials

October 17, 2006
Supersedes October 18, 2005

Matls. IM 213

TECHNICAL TRAINING & CERTIFICATION PROGRAM

GENERAL

The purpose of the Technical Training & Certification Program is to ensure Quality Control (QC)/Quality Assurance (QA) and Acceptance of Aggregates, Hot Mix Asphalt (HMA), Portland Cement Concrete (PCC), Grade Inspection, Precast and Prestressed Concrete, and Pavement Profiles and to ensure proper documentation of quality control/quality assurance and acceptance procedures and test results by industry and Contracting Authority personnel.

This Instructional Memorandum (IM) explains the requirements to become certified and to remain certified to perform inspection and testing in the State of Iowa. This IM also describes the duties, responsibilities and the authority of persons assigned the position of Certified Technician in any of the above areas for construction or maintenance projects. Appendix C of this IM lists what tests and procedures the technician is qualified to perform for each level of certification they obtain.

Through a cooperative program of training, study, and examination, personnel of the construction industry, State DOT, and other Contracting Authorities will be able to provide quality management and certified inspection. Quality control/quality assurance and acceptance sampling, testing and inspection will be performed by certified personnel and documented in accordance with the IMs.

A technician who is qualified and holds a valid certification(s) shall perform quality control/quality assurance and acceptance at a production site, proportioning plant, or project site. Responsibilities cannot be delegated to non-certified technicians. The duties of a Certified Technician may be assigned to one or more additional Certified Technicians.

The Technical Training & Certification Program will be carried out in accordance with general policy guidelines established or approved by the Highway Division Director. A Board of Certification composed of the following members will advise the Director:

Director – Office of Materials
Director – Office of Construction
Representative of District Materials Engineers**
Representative of District Construction Engineers**
Representative of Associated General Contractors (AGC of Iowa)
Representative of Iowa Concrete Paving Association (ICPA)
Representative of Asphalt Paving Association of Iowa (APAI)
Representative of Iowa Ready Mixed Concrete Association (IRMCA)
Representative of Iowa Limestone Producers Association (ILPA)
Representative of County Engineers
Coordinator of Technical Training & Certification Program**

** Appointed by Program Director

The Director of the Office of Materials will be the Program Director. Coordinators will be appointed by the Program Director to assist in administration of the program and to handle such planning, administration, and coordinating functions as may be needed.

TRAINING

The Iowa DOT will provide the training necessary to become certified or an agency approved by the Program Director. Producers/Contractors are encouraged to conduct their own pretraining program. A complete listing of training opportunities is available in the Technical Training & Certification Program's Information and Registration Booklet or at the Technical Training & Certification Program website, www.iowa.gov/dot/materials/training.htm. This book is available at any of the Iowa DOT Materials Offices. They may also be obtained from the ICPA, IRMCA, ILPA, and APAI.

CERTIFICATION REQUIREMENTS

1. A candidate must attend instruction and pass the examination(s) for all levels of certification prepared and presented by the Program Director or someone designated by the Program Director. If the new candidate fails the examination, they will have one opportunity to retake the examination. The retake must be completed within six months of the original exam. If they fail the retake of the examination, they will need to attend the training again before taking the examination the third time. If an individual is recertifying they will have only one opportunity to take the examination. If they fail the examination they must take the applicable training before retaking the examination.

2. All prerequisites shall be met before the applicant may attend the next level of training for the certification desired. A listing of certification levels and prerequisites is located in Appendix A.

3. Once the candidate has met all the criteria and has received certification, it is recommended the Certified Technician work under the supervision of an experienced technician until they become efficient in the inspection and testing methods they will be performing.

   An individual requesting to become certified as a Precast/Prestress Concrete Technician is required to obtain forty hours of experience assisting in quality control inspection at an approved plant before certification will be issued. The experience must be documented and shall be approved by the District Materials Engineer. This experience must be completed within two years from the date the individual attended the training.

4. Registered Professional Engineers, engineering graduates, and geology graduates from accredited institutions will be exempt from the training requirement in the areas they have had instruction. In order to obtain certification for any technical level, these persons must pass all applicable tests for the level of certification they wish to obtain. All certificates issued in accordance with these requirements will be subject to the same regulations concerning expiration, recertification, etc., as applies to certificates obtained via training and examinations.

Out-of-state technicians will be issued certifications when the following criteria are met:

1. The applicant must be certified in another state or shall have received equivalent training, if the state does not have a certification program, in each level of certification they are requesting.
2. The applicant must pass an examination for each level of certification desired, which will be administered by the Iowa Department of Transportation. Failure of the examination shall require the applicant to take the applicable schooling before they can retake the exam.
3. The applicant must follow the prerequisite requirements of the Technical Training & Certification Program.

Out-of-state applications should be submitted to the District Materials Office closest to the home location of the applicant. Copies of all the applicant's certifications must accompany the application.

CERTIFICATION

Upon successfully completing the requirements for certification, the Program Director will issue a certificate and a pocket certification card. This certification is not transferable. A certification shall be valid for five years.

CERTIFICATION IDENTIFICATION

The certificate will contain letters that identify the District of record, the certificate holder, certification number, the level of certification, and the expiration date of each level.

The assigned certification number may change if the certificate holder changes their residence.

RENEWAL OF CERTIFICATION

A certification shall be valid through December 31st of the fifth year. A 90-day grace period will be allowed. If the individual has not renewed their certification within the 90-day grace period, they are automatically decertified. The individual may obtain certification by taking the examination for the level of certification they are requesting. If the individual does not take the examination within one year after their certification(s) expire, i.e., 12/31/expiration year, they must retake all applicable schooling and pass the examinations. If an applicant becomes decertified in any level of certification and that certification is a prerequisite for other levels of certification the applicant will also be decertified in those related levels of certification.

All certified technicians will be required to pass an examination in each level of certification they hold before recertification will be issued. Failure of any level shall require the applicant to retake the applicable schooling and pass the test.

The certificate holder shall be responsible for applying for certification renewal and for maintaining a current address on file with the appropriate District Materials Office.

Technicians certified as Level I HMA and/or Level II PCC shall attend a minimum of two update classes each in the five-year period between certification and each recertification. The Iowa DOT or an agency or organization approved by the TTCP will hold these classes. These update classes will be listed in the Technical Training & Certification Program Booklet and on the program website, or the certified technician may contact the Iowa DOT for information. If an individual does not attend the two update classes required before their certification expires, they must take the entire schooling and pass the examination for the certification required.

The certified technician will not receive credit for the following:

1. More than one update per training season in each level of certification.
2. An update taken during the same training season in which the individual recertified.

UNSATISFACTORY PERFORMANCE NOTICE

A certified technician failing to perform the required specified duties or inadequately performing these duties, will receive an Unsatisfactory Notice (Office of Materials IM 213, Appendix B).The notice will be from the District Materials Engineer in the District where the failure occurred. This notice and all supporting documentation will be placed in the technician's permanent file with the District Materials Office in which the technician resides. The notice will also be placed on the statewide computer file.

SUSPENSION & DECERTIFICATION

A three-month suspension will be given upon receipt of two Unsatisfactory Performance Notices. Technicians that are suspended shall not perform any duties of the applicable certification, including any duties for which the affected certification is a prerequisite.

Technicians are eligible to be reinstated after the three-month suspension and successful completion of the applicable recertification test(s).

Technicians are subject to decertification when they receive a third Unsatisfactory Performance Notice.

Certified Technicians will be decertified for any of the following reasons:

The certificate will become invalid for the following reasons:

1. Failure of the certificate holder to renew the certificate prior to regular expiration as described above.
2. Use of false or fraudulent information to secure or renew the certificate.
3. Use of false or fraudulent actions or documentation by the certificate holder.
4. Not performing tests and technician duties properly and in accordance to specifications.

Action will be effective on the date the Program Director issues the suspension or decertification notice.

Technicians that are decertified shall not perform any duties requiring certification. Technicians may request reinstatement after one year.

Appeals and reinstatement requests shall be submitted in writing to the Program Director. Appeals and reinstatement requests will be considered by the Certification Board.

If reinstatement is authorized, the applicant must attend and successfully complete the applicable certification courses.

FUNCTIONS & RESPONSIBILITES

A certificate holder at each production site, project site, proportioning plant, or laboratory will perform duties. The certified technician shall perform quality control testing in accordance with specified frequencies and submit designated reports and records.

The specification requirement for materials testing by a certified technician does not change the supplier's responsibilities to furnish materials compliant with the specification requirements.

The District Materials Engineer and/or Project Engineer will be responsible for monitoring the sampling, testing, production inspection activities and quality control performed by the contractor. A monitor shall have satisfactorily completed the training and be certified for the level of technician they are monitoring.

The District Materials Engineer and/or Project Engineer will have authority and responsibility to question and where necessary, require changes in operations and quality control to ensure specification requirements are met.

QUALITY CONTROL, TESTING, & DOCUMENTATION

The QC Technician shall be present whenever construction work related to production activity, such as stockpiling or other preparatory work, requires record development and/or documentation is in progress. The QC Technician's presence is normally required on a continuing basis beginning one or more days before plant operation begins and ending after plant shut down at the completion of the project. The work shall be performed in a timely manner and at the established frequencies.

The QC Technician's presence is not normally required during temporary plant shut downs caused by conditions, such as material shortages, equipment failures, or inclement weather.

All quality control activities and records shall be available and open for observation and review by representatives of the contracting authority.

Reports, records, and diaries developed during progress of construction activities will be filed as directed by the Contracting Authority and will become the property of the Contracting Authority.

Quality control activities, testing, and records will be monitored regularly by Contracting Authority representatives. The Project Engineer or District Materials Engineer will assign personnel for this function.

Monitor activities will be reported and filed at prescribed intervals with the Project Engineer, District Materials Engineer, producer, contractor, and the contractor's designated producer.

At no time will the monitor inspector issue directions to the contractor, or to the QC Technician. However, the monitor inspector will have the authority and responsibility to question, and where necessary, reject any operation or completed product, which is not in compliance with contract requirements.

ACCEPTANCE

Completed work will be accepted on the basis of specification compliance documented by acceptance test records, and monitor inspection records. Specification noncompliance will require corrective action by the producer, contractor, or by the contractor's designated producer, and review of events and results associated with noncompliance by the Project Engineer.

CERTIFICATION LEVELS

CERTIFICATION LEVEL	TITLE	PRE-REQUISITES
	AGGREGATE	
Level I Aggregate	Certified Sampling Technician	None
Level II Aggregate	Certified Aggregate Technician	Level I Aggregate
	PORTLAND CEMENT CONCRETE	
Level I PCC**	PCC Testing Technician	None
Level II PCC	PCC Plant Technician	Level II Aggregate & Level I PCC
Level III PCC	PCC Mix Design Technician	Level II PCC

**American Concrete Institute (ACI) Grade I certification will be acceptable as a portion of the Level I PCC training.

	HOT MIX ASPHALT	
HMA Sampler	HMA Sampler	None
Level I HMA	HMA Technician	Level II Aggregate
Level II HMA	HMA Mix Design Technician	Level I HMA
	PROFILOGRAPH	
Profilograph	Profilograph Technician	None
	PRESTRESS	
Prestress	Prestress Technician	Level I PCC or ACI Grade I *If the technician will be performing gradations, they will need to be Aggregate Level II- certified.*

UNSATISFACTORY PERFORMANCE NOTICE

Issued To: ______________________________

____

____

Date: ____________________

This notice is to inform you that your performance as a Certified Inspector/Technician was unsatisfactory for the reason(s) listed below.

This notice will be placed in your permanent file with the District Materials Office in which you reside. It will also be placed on the statewide computer file.

The goal of the Technical Training and Certification Program (TTCP) is to work with contractors, producers, cities, and counties to continually improve the quality of Iowa's construction projects. We hope you will work with us to achieve this goal.

Unsatisfactory Performance:

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____

District Materials Engineer

cc: Program Director – Materials Engineer, Ames
TTCP Coordinator
Resident Construction Engineer

CERTIFIED TECHNICIANS QUALIFICATIONS

Tests and Procedures the Certified Technician is qualified to perform for each level of certification.

LEVEL I AGGREGATE

- IM 204 - Inspection of Construction Project Sampling & Testing (when material is incorporated)
- IM 209, App. C - Aggregate Specification Limits & Sampling & Testing Guide (when material is produced)
- IM 301 - Aggregate Sampling Methods

LEVEL II AGGREGATE

- IM 216 - Guidelines for Verifying Certified Testing Results
- IM 302 - Sieve Analysis of Aggregates
- IM 306 - Determining the Amount of Material Finer Than #200 (75µm) Sieve in Aggregate
- IM 307 - Determining Specific Gravity of Aggregate
- IM 308 - Determining Free Moisture & Absorption of Aggregate
- IM 336 - Methods of Reducing Aggregate Field Samples to Test Samples
- IM 344 - Determining the Amount of Shale in Fine Aggregate
- IM 345 - Determining the Amount of Shale in Coarse Aggregate

LEVEL I PCC

- IM 204 - Inspection of Construction Project Sampling & Testing
- IM 208 - Materials Laboratory Qualification Program
- IM 216 - Guidelines for Verifying Certified Testing Results
- IM 315 - Method of Protecting, Curing, Making & Testing Concrete Cylinders
- IM 316 - Flexural Strength of Concrete
- IM 317 - Slump of Hydraulic Cement Concrete
- IM 318 - Air Content of Freshly-Mixed Concrete by Pressure
- IM 327 - Sampling Freshly-Mixed Concrete
- IM 328 - Making, Protecting, and Curing Concrete Flexural Specimens
- IM 340 - Weight Per Cubic Foot, Yield, & Air Content (Gravimetric) of Concrete
- IM 383 - Testing the Strength of PCC Using the Maturity Method
- IM 385 - Temperature of Freshly-Mixed Concrete
- IM 525 - Designing Flowable Mortar
- Iowa 410-B - Method of Test for Flow of Grout Mixtures
- AASHTO T97 - Third Point Loading

LEVEL II PCC

- IM 527 - Paving Plant Inspection
- IM 528 - Structural Concrete Plant Inspection
- IM 529 - PC Concrete Proportions

LEVEL III PCC

- IM 530 - Quality Management & Acceptance of PC Concrete Pavement
- IM 531 - Test Method for Combining Aggregate Gradations
- IM 532 - Aggregate Proportioning Guide for Portland Cement Concrete Pavement

HMA SAMPLER

- IM 322 - Method of Sampling Uncompacted Hot Mix Asphalt
- IM 323 - Method of Sampling Asphaltic Materials

LEVEL I HMA

- IM 204 - Inspection of Construction Project Sampling & Testing
- IM 208 - Materials Laboratory Qualification Program
- IM 216 - Guidelines for Verifying Certified Testing Results
- IM 320 - Method of Sampling Compacted Asphalt Mixtures
- IM 321 - Method of Test for Compacted Density of Hot Mix Asphalt (HMA) (Displacement)
- IM 322 - Method of Sampling Uncompacted Hot Mix Asphalt
- IM 323 - Method of Sampling Asphaltic Materials
- IM 325 - Compacting Asphalt Concrete by the Marshall Method
- IM 325G - Method of Test for Determining the Density of Hot Mix Asphalt (HMA) Using the Superpave Gyratory Compactor (SGC)
- IM 337 - Determining Thickness of Completed Courses of Base, Subbase, & Hot Mix Asphalt
- IM 350 - Maximum Specific Gravity of Hot Mix Asphalt (HMA) Mixtures
- IM 357 - Preparation of Hot Mix Asphalt (HMA) Mix Samples for Test Specimens
- IM 501 - Asphaltic Terminology, Equations & Example Calculations
- IM 508 - Hot Mix Asphalt (HMA) Plant Inspection
- IM 509 - Tank Measurement & Asphalt Cement Content Determination
- IM 511 - Control of Hot Mix Asphalt (HMA) Mixtures
- IM 514 - Correlation of Field Density for Hot Mix Asphalt (HMA) Paving

LEVEL II HMA

- IM 380 - Vacuum-Saturated Specific Gravity & Absorption of Combined or Individual Aggregate Sources
- IM 510 - Method of Design of Hot Mix Asphalt (HMA) Mixes
- AASHTO T176 - Plastic Fines in Graded Aggregate & Soils by use of Sand Equivalent Test
- AASHTO T304 - Uncompacted Void Content of Fine Aggregate
- ASTM D 4791 - Flat Particles, Elongated Particles, or Flat & Elongated Particles in Coarse Aggregate

PROFILOGRAPH

- IM 341 - Determining Pavement & Bridge Ride Quality

PRESTRESS

- IM 570 - Precast & Prestressed Concrete Bridge Units

AGGREGATE TECHNICIAN DUTIES

Duties of the Aggregate Technician are detailed in IM 209 and the IM 300 Series and consist of, but are not limited to the following:

A. Sampling

  1. Obtain representative samples by approved method(s).
  2. Sample at required frequencies.
  3. Identify samples with pertinent information such as:
     a. Type of material
     b. Intended use
     c. Production beds working depth
     d. Sampling method

B. Gradation Testing

  1. Follow appropriate gradation testing methods.
  2. Maintain current applicable specifications.
  3. Post test results within 24 hours of sampling.

C. Other Testing as Required (specific gravity, moisture, deleterious material, etc.)

  1. Follow appropriate testing methods.
  2. Maintain current applicable specifications.
  3. Complete required reports.

D. Sampling & Testing Equipment

  1. Clean and check testing sieves for defects.
  2. Assure scale accuracy.
  3. Maintain sampling and testing equipment.

E. Communication

1. Notify the District Materials office for production start-up or changes.
2. Relay test results to appropriate production or supervisory personnel.
3. Report failing test results immediately to appropriate personnel (including District Materials office) and assure remedial actions are taken.

F. General

1. Monitor stockpiling procedures to avoid contamination and excess segregation.
2. Assure proper identification of stockpiles.
3. Assure specification requirements for intended use are met before shipment.
4. Assure sampling locations are safe.
5. Assure proper bedding planes or production depths are maintained.

G. Documentation

1. Report all production test results of certified aggregates on Form #821278 and distribute as required.
2. Assure "plant production log" is maintained.

PORTLAND CEMENT CONCRETE (PCC) TECHNICIAN DUTIES
PAVING & STRUCTURAL CONCRETE

The Quality Control Technician shall have no other duties while performing certified inspection duties. The District Materials Engineer may approve all quality control activities be performed by a single certified technician for low production situations.

Many of the duties of the PCC Level II Technician are detailed in IM 527 (Paving) and IM 528 (Structural) and consist of, but are not limited to the following:

A. Stockpiles

   1. Assure proper stockpiling procedures.
   2. Prevent intermingling of aggregates.
   3. Prevent contamination.
   4. Prevent segregation.

B. Plant Facilities

   1. Assure safe sampling locations.
   2. Check for equipment compliance.
   3. Assure proper laboratory location and facilities.

C. Calibration

   1. Be present during calibration (paving).
   2. Check plant calibration (structural).
   3. Assure proper batch weights.

D. Cement (Fly Ash) & Aggregate Delivery

   1. Check for proper sources and certification.
   2. Document quantities delivered.
   3. Monitor condition of shipments.

E. Plant Sampling

  1. Check aggregate gradations by obtaining, splitting, and testing samples.
  2. Check aggregate moistures and specific gravity.

F. Proportion Control

  1. Check scale weights and operation.
  2. Check admixture dispensers.
  3. Check mixing time and revolutions.
  4. Check cement yield. (Paving plant only, unless over 10,000 cu. yds.)

G. Concrete Tests

  1. Cure flexural test specimens.
  2. Test flexural specimens (Contract agency will perform test in structural plant).
  3. Conduct maturity testing.

H. Test Equipment

  1. Clean and maintain scales, screens, pycnometers and beam molds, and laboratory facility.

I. Documentation

  1. Prepare daily plant reports (paving), weekly plant reports (structures).
  2. Document all checks and test results in the field book.
  3. Maintain daily diary of work activity.

HOT MIX ASPHALT (HMA) TECHNICIAN INSPECTION DUTIES

The following is a list of the duties that must be performed by the Certified Level I HMA Technicians doing quality control work for the Contractor on all projects where the Quality Management-Asphalt (QM-A) specification applies.

These duties consist of, but are not limited to, the following:

A. Aggregate Stockpiles.

  1. Assure proper stockpiling of aggregate deliveries. (stockpile build & additions) (daily check list, IM 508)
    a. Prevent intermingling of aggregates.
    b. Check for and prevent contamination.
    c. Prevent segregation.
    d. Check for oversize material.

  2. Document certified aggregate deliveries. (each delivery) (plant book, IM 508)
    a. Obtain truck tickets.
    b. Check for proper certification.
    c. Check for proper approved source.
    d. Enter deliveries in Plant Book Program, Aggregate Certification page.

  3. Observe loader operation. (daily) (daily check list, IM 508)
    a. Check for proper stockpile to bin match-up.
    b. Check that loader does not get stockpile base material in load.
    c. Check that loader does not intermingle aggr. by overloading bins.

B. Asphalt Binder Delivery. (each delivery) (plant report & plant book, IM 508 & 509)

  1. Check that material is pumped into correct tank.

  2. Document Deliveries.
    a. Obtain truck tickets.
    b. Check for proper approved source.
    c. Check for proper certification.
    d. Check for proper grade.
    e. Check for addition of liquid anti-strip if required.
    f. Check if weight per gallon or specific gravity has changed.
    g. Enter deliveries into Plant Book Program, Asphalt Binder Shipment Log page.

C. Plant Operations. (daily)

1. Prepare Plant Report Program for daily entries. (plant report, IM 511)
    a. Enter Date.
    b. Enter Report Number.
    c. Enter expected tonnage for the day.
    d. Enter any proportion or target changes that apply.

2. Aggregate Delivery System. (daily check list, IM 508)
    a. Check for proper cold feed gate settings.
    b. Check for proper cold feed belt speed settings.
    c. Check for proper moisture setting (drum plants).
    d. Monitor RAP proportions

3. Mixing System. (daily check list, spec 2303.03, IM 508)
    a. Check for proper asphalt binder delivery setting.
    b. Check for proper interlock operation.
    c. Monitor coating of aggregates.
    d. Monitor mixing time (batch plants).

4. Loading System. (daily check list, spec 2303.03 & 2001.01, IM 508)
    a. Check hopper/silo gates for proper open/close
    b. Check trucks for proper loading and possible segregation.
    c. Check trucks for diesel fuel contamination in box and remove contaminated trucks from service (5 hrs with box raised).

5. Asphalt Binder Quantity Determination. (plant report, IM 508 & 509)
    a. Perform start-up tank stick measurement before mix production begins (if applicable).
    b. Perform final tank stick measurement after mix production is done (if applicable).
    c. Perform intermediate tank stick measurements as needed.
    d. If using meter for quantity, obtain totalizer printout readings and periodically check against tank stick readings.
    e. If using batch count for quantity, obtain printouts of each batch and add up the asphalt binder used for total quantity.

D. Plant Operations. (2 hour intervals) (plant report, IM 508)

1. Temperatures.
    a. Monitor and record mix temperature at discharge into truck box.
    b. Monitor and record asphalt binder temperature.

   c. Monitor and record air temperature.

2. Observe plant operation for any irregularities.

E. Weighing Equipment.

1. Proportioning scales (batch plants). (min. 1/day) (spec 2001.07 & .20) (daily check list, IM 508)
   a. Perform sensitivity checks of scales.
   b. Check for interference at scale pivot points.

2. Pay Quantity Scales. (min. 1/day) (spec 2001.07 & .20, IM 508) (daily check list, plant book)
   a. Regularly perform check weighing comparisons with a certified scale as necessary. (min. 1st day and one additional if >5000 tons, and as directed by Engineer)
   b. Perform sensitivity checks of scales.
   c. Check for interference at scale pivot points.
   d. Perform verification weighing (truck platform scales).

3. Weigh Belts. (daily) (daily check list)

   a. Check weigh belt for excess clinging fines that effects speed reading.
   b. Check weigh belt for interference at bridge pivot points.
   c. Check for proper span setting.

4. Enter scale checks in Plant Book Program, Daily Check List or Plant Scale Checks page. (daily) (plant book)

F. Plant Sampling. (daily) (spec 2303.04, IM 204 & 511)

1. Obtain cold-feed gradation samples as directed by Contracting Authority personnel per IM 301and IM 204.

2. Obtain asphalt binder samples as directed by Contracting Authority personnel per IM 323 and IM 204.

3. Enter sample data into Plant Book Program, Sample Log page.

4. Obtain cold-feed moisture samples at a minimum of every ½ day (drum mix plants).

G. Field Sampling (if not performed by others). (daily) (spec 2303.04, IM 204 & 511)

1. Obtain uncompacted mix random samples as directed by Contracting Authority personnel, and identify time, station, lift and side.

3. Obtain compacted mix core random samples as directed by Contracting Authority personnel.

H. Testing. (daily) (spec 2303.04, IM 204 & 511)

1. Field cores.

    a. Provide properly calibrated equipment for Contracting Authority technician's use.
    b. Obtain and record core location station and offset information.
    c. Obtain copy of core thickness measurements from Contracting Authority Technician.
    d. Obtain copy of core weights from Contracting Authority technician.
    e. Record weights and thickness in Plant Report Program.
    f. Enter sample data into Plant Book Program Sample Log page.

2. Uncompacted mix.

    a. Properly store Contracting Authority secured portion of paired sample.
    b. Split Contractor half of paired sample into test portions as per IM 357.
    c. Perform gyratory compaction as per IM 325G.
    d. Perform bulk specific gravity test of laboratory-compacted specimen as per IM 321.
    e. Perform maximum specific gravity test as per IM 350.
    f. Enter test data into Plant Report Program.
    g. Submit secured samples to DOT District Lab.
    h. Enter sample data into Plant Book Program, Sample Log page.

3. Aggregate.

    a. Split one sample each day as directed by Contracting Authority personnel and provide half for testing by Contracting Authority.
    b. Perform gradation analysis as per IM 302 and enter weights into Plant Report Program.
    c. Perform moisture tests and enter weights into Plant Book Program, Plant Moistures page (drum mix plants).

4. Testing Lab Qualification. (as needed) (IM 208 & 511)

    a. Record all HMA sample validations with DOT on form 235.
    b. Document corrective actions taken when not correlating.
    c. Document all test equipment calibrations.
    d. Update IM's, test procedures and specs as required.

I. Documentation. (daily) (spec 2303.04, plant report, plant book, IM 204, 511 & 508)

1. Prepare computerized Daily Plant Report (form 241).
    a. Check that all data is correct.
    b. Check that all data is complete.
    c. Compute moving averages for gradation and lab voids.
    d. Compute tons of mix used to date.
    e. Enter mix adjustment data on report.
    f. Check for spec compliance.
    g. Immediately report non-complying results.
    h. Obtain and record mat temperatures and stationing.
    i. Provide daily Plant Report printout to DME.

2. Maintain a daily diary of work activity in Plant Report Program.
    a. Record weather conditions.
    b. Record daily high and low temperatures.
    c. Record sunrise and sunset times.
    d. Record any interruptions to plant production.
    e. Record any other significant events.

3. Copy and export daily data and paste into control charts program.

4. Enter all asphalt binder or aggregate proportion changes in Plant Book Program, Mix Adjustments page.

5. Enter tack shipment quantities in Plant Book Program, Tack Shipment Log page.

6. Total all truck tickets delivered to project and deduct any waste to determine HMA pay quantity.

J. Miscellaneous. (daily) (daily check list, IM 208 & 511)

1. Fill out Plant Book Program, Daily Check List page.

2. Clean lab.

3. Back-up computer files.

4. Dispose of samples as directed by District Lab.

5. Clean and maintain lab equipment.

K. Independent Assurance Duties. (Every 3 months) (IM 205 & 216)

1. Pick up HMA and aggregate proficiency sample from District Lab.

2. Test aggregate proficiency sample for gradation per IM 302.

3. Test HMA proficiency sample per IM 357, 325G, 321 & 350.

4. Report test results on proficiency samples to Central Materials Office per IM 205.

L. Project Duties. (1/project) (IM 508 & 511)

1. Be in possession of appropriate mix design.

2. Be present during plant calibration.

3. Observe scale calibrations.

4. Perform plant site and set-up inspection and fill out Plant Site Inspection List.

5. Set up Plant Report and Plant Book Programs and enter all project information to create Project Master files at beginning of project.

6. Check that release agents used in truck boxes are on the approved list in IM 491.15

7. Copy all computer files and provide to the Contracting Authority at completion of project.

8. Copy all paperwork and control charts and provide to the Contracting Authority at completion of project.

PRESTRESS TECHNICIAN DUTIES

Duties of the Prestress Technician are detailed in IM 570 and consist of, but are not limited to the following:

A. Pre-pour

1. Identify and document materials requiring outside fabrication inspection.
2. Identify potential fabrication or production problems and notify Iowa DOT inspectors.
3. Verify that all materials incorporated meet the requirements of the contract documents.
4. Review concrete placement documents for strand locations.
5. Check tension calculations.
6. Measure elongation and gauge pressure during tensioning.
7. Check hold down and insert locations.
8. Check stress distributions.
9. Check steel reinforcement and placement.
10. Check strand position.
11. Check condition of pallet.
    a. Level
    b. Holes
    c. Gaps
    d. Other deformities
12. Determine moisture of aggregates.
13. Check form condition and placement.
    a. Oil
    b. Line alignment level
    c. Tightness

B. Concrete Placement

1. Check on use of an approved mix design and batching operations (sequence).
2. Assure appropriate placement and proper vibration techniques.
3. Measure and record concrete temperature.
4. Assure test cylinders are properly made.
5. Assure appropriate finish.
6. Assure appropriate curing operations.

C. Post-pour

1. Check temperature and record during curing process.
2. Assure concrete strength has been met prior to releasing the line.
3. Assure proper detensioning procedure.
4. Check unit for defects and obtain approval for repairs.
5. Identify and store cylinders with the respective units.
6. Check beam ends for fabrication in accordance with the plans.
7. Assure exterior sides of facia beams are grouted.
8. Inspect after patching and desired surfacing.
9. Measure and record overall dimensions of beam.
10. Measure and record camber at release and compare to design camber.
11. Check and/or measure and record lateral sweep before shipping.
12. Assure proper cylinder cure.

PROFILOGRAPH TECHNICIAN DUTIES

Duties of the Profilograph Technician are detailed in IM 341 and consist of, but are not limited to the following:

A. Test pavement for smoothness criteria.

B. Evaluate and certify test results.

  1. Certified person that reduces trace must sign certified test report.

  2. Profilograms become part of permanent project record.

C. Documentation

  1. Certified Profilograph Test report must include following statement:

     This is to certify that all testing and trace reduction herein described has been performed according to applicable contract specifications and requirements.

FEDERAL CODE 1020 and IOWA CODE 714.8

I.M. 213 discusses the Unsatisfactory Notice that Certified Technicians are given when they are not performing their job duties satisfactorily. This can be given for a number of reasons including, improper sampling and/or testing, not performing their duties and reporting in the time frame required, reporting incorrect information, etc. The technician is given one written notice, the second notice is three-month certification suspension, and the third notice is decertification. According to I.M. 213 the Certified Technician can automatically be decertified for false statements without going through the Unsatisfactory Notice procedure. The Certified Technician also needs to be aware of the false statement clause that is applicable to all federal-aid projects and the fraudulent practice clause that applies to all non-federal aid projects. **Certified Technicians need to read and be aware of U.S.C. 1020 and Iowa Code 714.8 since these do apply to them.** They read as follows:

FEDERAL AID PROJECTS

IX. FALSE STATEMENTS CONCERNING HIGHWAY PROJECTS

In order to assure high quality and durable construction in conformity with approved plans and specifications and a high degree of reliability on statements and representations made by engineers, contractors, suppliers, and workers on Federal-aid highway projects, it is essential that all persons concerned with the project perform their functions as carefully, thoroughly, and honestly as possible. Willful falsification, distortion, or misrepresentation with respect to any facts related to the project is a violation of Federal law. To prevent any misunderstanding regarding the seriousness of these and similar acts, the following notice shall be posted on each Federal-aid highway project (23 CFR 635) in one or more places where it is readily available to all persons concerned with the project:

NOTICE TO ALL PERSONNEL ENGAGED ON FEDERAL-AID HIGHWAY PROJECTS

18 U.S.C. 1020 reads as follows:

"Whoever, being an officer, agent, or employee of the United States, or of any State or Territory, or whoever, whether a person, association, firm, or corporation, knowingly makes any false statement, false representation, or false report as to the character, quality, quantity, or cost of the material used or to be used, or the quantity or quality of work performed or to be performed, or the cost thereof in connection with the submission of plans, maps, specifications, contracts, or costs of construction on any highway or related project submitted for approval to the Secretary of Transportation; or

Whoever knowingly makes any false statement, false representation, false report or false claim with respect to the character, quality, quantity, or cost of any work performed or to be performed, or materials furnished or to be furnished, in connection with the construction of any highway or related project approved by the Secretary of Transportation; or

Whoever knowingly makes any false statement or false representation as to material fact in any statement, certificate, or report submitted pursuant to provisions of the Federal-aid Roads Act approved July 1, 1916, (39 Stat. 355), as amended and supplemented;

Shall be fined not more than $10,000 or imprisoned not more than 5 years or both"

NON-FEDERAL AID PROJECTS

Iowa Code 714.8, subsection 3, defines fraudulent practices. "A person who does any of the following acts is guilty of a fraudulent practice. Subsection 3, Knowingly executes or tenders a false certification under penalty of perjury, false affidavit, or false certificate, if the certification, affidavit, or certificate is required by law or given in support of a claim for compensation, indemnification, restitution, or other payment." Depending on the amount of money claimed for payment, this could be a Class C or Class D felony, with potential fines and/or prison.

The above codes refer to the individual making the false statement. **Standard Specification Article 1102.03, paragraph C. section 5 refers to the Contractor.**

Article 1102.03, paragraph C, section 5 states, "A contractor may be disqualified from bidder qualification if or when: The contractor has falsified documents or certifications, or has knowingly provided false information to the Department or the Contracting Authority."

October 16, 2007
Supersedes October 17, 2006

Matls. IM 216

GUIDELINES FOR VALIDATING TEST RESULTS

GENERAL

Agency laboratory and field personnel validate testing by Contractor and producer personnel on a regular basis. Tolerances given herein are for use as guides to flag test result variations that indicate a possible discrepancy.

TOLERANCES

The tolerances shown in the following listing apply to the difference between Contractor and producer test results and verification test results. When the tolerances are exceeded, an immediate investigation must be made to determine possible cause so that any necessary corrections can be made.

TEST NAME	TEST METHOD	TOLERANCE
Slump of PC Concrete	IM 317	1/4 in. (6 mm)
Air Content of PC Concrete	IM 318	0.4%
Length of Concrete Cores	IM 347	0.10 in. (2 mm)
Free Moisture in Aggregate, by Pycnometer	IM 308	0.2%
Specific Gravity of Aggregate, by Pycnometer	IM 307	0.02
Moisture in Aggregate, by Hot Plate		0.3%
Wet Density by Nuclear Gauge, Soils & Bases	IM 334	2.0 lb./ft.^{3} (32 kg/m^3)
G_{mm} Maximum Specific Gravity	IM 350	0.010
G_{mb} Density of HMA Concrete, by Displacement	IM 321	0.020
G*/Sin Delta	T315	10% of mean
% Binder, Ignition Oven	IM 338	0.3%
G_{sa} Apparent Specific Gravity	IM 380	0.010
G_{sb} Bulk Specific Gravity	IM 380	0.028
Percent Absorption	IM 380	0.37%
Fine Aggregate Angularity	T304	2
Sand Equivalency	T176	10 % of mean

Pavement Profile Index (0.2" blanking band)	IM 341	
Verification Profile Index Test Result		
Inches/mile (mm/km)		
6.0 (95) or less		1.0 in./mi. (16 mm/km)
6.1 to 20.0 (96 to 315)		2.0 in./mi. (32 mm/km)
20.1 to 40.0 (316 to 630)		3.0 in./mi. (47 mm/km)
More than 40.0 (630)		5.0 in./mi. (79 mm/km)
Pavement Profile Index (0.0" blanking band)	IM 341	
Verification Profile Index Test Result		
Inches/mile (mm/km)		
25.0 (395) or less		3.0 in./mi. (47 mm/km)
25.1 to 40.0 (396 to 630)		4.0 in./mi. (63 mm/km)
More than 40.0 (630)		5.0 in./mi. (79 mm/km)
Bridge Profile Index (0.2" blanking band)	IM 341	
Verification Profile Index Test Result		
Inches/mile (mm/km)		
6.0 (95) or less		2.0 in./mi. (32 mm/km)
6.1 to 20.0 (96 to 315)		3.0 in./mi. (47 mm/km)
20.1 to 40.0 (316 to 630)		4.0 in./mi. (63 mm/km)
More than 40.0 (630)		6.0 in./mi. (95 mm/km)

TOLERANCES FOR AGGREGATE GRADATIONS

Determining the precision of an aggregate sieve analysis presents a special problem because the result obtained with a sieve is affected by the quantity of material retained on the sieve and by results obtained on sieves coarser than the sieve in question. Tolerances are, therefore, given for different ranges of percentage of aggregate passing one sieve and retained on the next finer sieve used.

Comparisons of test results are made on each fraction of the sample, expressed in percent that occurs between consecutive sieves.

NOTE: Tolerances for aggregate gradations are only valid if the two tests were made on a split sample. Experience has shown that improper sample reduction, as well as differences in test procedures can contribute to results being out of tolerance. When a comparison exceeds the tolerance limits, a review of the test procedures and equipment will be performed. Where practical, additional comparisons will be done with similar equipment and methods.

Table 1 Tolerances for All Aggregates Except HMA-Combined Aggregate

	Size Fraction Between Consecutive Sieves, %*	Tolerance, %
Coarse Portion: #4 Sieve and larger	0.0 to 3.0	2
	3.1 to 10.0	3
	10.1 to 20.0	5
	20.1 to 30.0	6
	30.1 to 40.0	7
	40.1 to 50.0	9
Fine portion: #8 Sieve and smaller	0.0 to 3.0	1
	3.1 to 10.0	2
	10.1 to 20.0	3
	20.1 to 30.0	4
	30.1 to 40.0	4

Table 2 Tolerances for All HMA-Combined Aggregate

Size Fraction Between Consecutive Sieves, %*	Tolerances
0.0 to 3.0	2
3.1 to 10.0	3
10.1 to 20.0	5
20.1 to 30.0	6
30.1 to 40.0	7
40.1 to 50.0	9

*The verification test analysis fraction is used to find the proper tolerance.

COMPARISON OF AGGREGATE GRADATIONS

Use of these tolerances is explained in the following examples. Computer spreadsheets to perform the analysis are available on the Iowa DOT Materials Office website. Use of the spreadsheets is preferred when possible. Appendix A contains a copy of the printouts from the spreadsheets.

Example 1 - PC Concrete Coarse Aggregate

Sieve Size	DOT Coarse Aggr Percent Passing	Prod./CPI Coarse Aggr Percent Passing	DOT Coarse Aggr Percent Retained	Prod./CPI Coarse Aggr Percent Retained	Fraction Difference	Applicable Tolerance	Complies
1.5"/37.5mm	100.0	100.0	0.0	0.0	0.0	2	Yes
1"/25.0mm	97.1	99.1	2.9	0.9	2.0	2	Yes
3/4"/19.0mm	72.2	65.1	24.9	34.0	9.1	6	No
1/2"/12.5mm	38.1	34.9	34.1	30.2	3.9	7	Yes
3/8"/9.5mm	12.0	8.8	26.1	26.1	0.0	6	Yes
#4/4.75mm	0.6	0.2	11.4	8.6	2.8	5	Yes
#8/2.36mm	0.5	0.2	0.1	0.0	0.1	1	Yes
Minus #200	0.3	0.2	0.3	0.2	0.1	1	Yes

The size fraction between consecutive sieves is found by calculating the difference between the percent passing reported for the two sieves. For example, the fraction between the 1.5 in. (37.5 mm) and 1 in. (25 mm) sieves for the above verification test is 100.0 - 97.1 = 2.9%. Between the 1/2 in. (12.5 mm) and 3/8 in. (9.5mm) sieves it is 38.1 – 12.0 = 26.1%. Since nothing passes the pan, the size fraction between the #200 sieve and the pan is equal to the percent passing the #200.

The example shows the fraction between each pair of consecutive sieve sizes for both tests and the difference between these fractions for both tests. The difference is compared with the applicable tolerance to determine a disposition. In this example, a suspect result is found in the fraction between the 1 in. (25 mm) and 3/4 in. (19 mm) sieves. Since the suspect difference is due primarily to the percent passing results on the 3/4 in. (19 mm) sieves, it is these results that should at least be investigated first. Only further investigation can determine which 3/4 in. (19 mm) sieve, if any is faulty.

NOTE: The applicable tolerance changes between #4 and #8 size fractions.

Example 2 - PC Concrete Fine Aggregate

Sieve Size	DOT Fine Aggregate Percent Passing	Prod./CPI Fine Aggregate Percent Passing	DOT Fine Aggregate Percent Retained	Prod./CPI Fine Aggregate Percent Retained	Fraction Difference	Applicable Tolerance	Complies
3/8"/9.5mm	100.0	100.0	0.0	0.0	0.0	2	Yes
#4/4.75mm	95.0	95.0	5.0	5.0	0.0	3	Yes
#8/2.36mm	87.8	86.3	7.2	8.7	1.5	2	Yes
#16/1.18mm	72.0	71.5	15.8	14.8	1.0	3	Yes
#30/600um	44.0	43.8	28.0	27.7	0.3	4	Yes
#50/300um	12.2	13.0	31.8	30.8	1.0	4	Yes
#100/150um	1.5	1.3	10.7	11.7	1.0	3	Yes
Minus #200	0.4	0.4	0.4	0.4	0.0	1	Yes

Example 3 - HMA Combined Aggregate

		Sieve Sizes										
		1"	3/4"	1/2"	3/8"	4	8	16	30	50	100	200
	Specs.											
	D.O.T.		100	99.1	87.3	68.8	54.2	41.4	28.2	15.5	9.1	6.9
	Prod./C.P.I.		100	98.8	86.1	74.9	56.1	41.9	28.7	15.1	10.9	8.6

D.O.T. % Retained	Prod./C.P.I. % Retained	Diff.	Tol. %	Comply (Y/N)
NA	NA	0.0	2	Y
0.9	1.2	0.3	2	Y
11.8	12.7	0.9	5	Y
18.5	11.2	7.3	5	N
14.6	18.8	4.2	5	Y
12.8	14.2	1.4	5	Y
13.2	13.2	0.0	5	Y
12.7	13.6	0.9	5	Y
6.4	4.2	2.2	3	Y
2.2	2.3	0.1	2	Y
6.9	8.6	1.7	3	Y

D.O.T. FBR: ______

Sieve Fraction Between Consecutive Sieves, %	Tolerance, %
0.0 To 3.0	2
3.1 To 10.0	3
10.1 To 20.0	5
20.1 To 30.0	6
30.1 To 40.0	7
40.1 To 50.0	9

NOTE: The applicable tolerance for this combined aggregate sample is from Table 2. In this example, the suspect fractions would indicate a possible problem for two pairs of consecutive sieve sizes involving the #4 (4.75 mm) sieves. This evidence and the difference in the test values found for the #4 (4.75 mm) sieves, strongly point to an error in one of the #4 (4.75 mm) sieve results.

When RAP mixes are used, the comparison data is of the composite gradation results and not of the cold feed.

PC CONCRETE GRADATION COMPARISON REPORT
(Computer Spreadsheet Available on Iowa DOT Office of Materials Web Site)

Rev 05/03

Iowa Department Of Transportation

Reported Gradation & IM 216 Comparison Report

Form 200

Project No.: ____________________

Contract ID: ____________________

County: ____________________

Contractor/Producer: ____________________

Design No.: ____________

Coarse Agg. T203 A No.: ________

Fine Agg. T203 A No.: ________

Proper Equipment: ________

Applicable Specs.: ________

Intended Use: ____________________
(Paving, Structure, Patching, Incidental

	Good	Fair	Poor
Care of Equipment:	____	____	____
Sampling Procedure:	____	____	____
Splitting Procedure:	____	____	____
Sieving to Completion:	____	____	____
Computations:	____	____	____
Reporting:	____	____	____

DOT Tested By: ____________________ Cert. No.: __________ Date: __________

Contr./Prod. Tested By: ____________________ Cert. No.: __________ Date: __________

			Sieve Sizes - Percent Passing											
			1 1/2"	1"	3/4"	1/2"	3/8"	#4	#8	#16	#30	#50	#100	#200
Grad No.	Sample ID	**Specs**												
		DOT												
		Contr./Prod.												

Grad No.	Sample ID					**Specs**								
		DOT												
		Contr./Prod.												

Sieves	DOT % Retained	Contr./Prod. % Retained	Diff.	Tol. %	Comply (Y/N)
1 1/2 - 1	NA	NA	0.0	2	Y
1 - 3/4	NA	NA	0.0	2	Y
3/4 - 1/2	0.0	0.0	0.0	2	Y
1/2 - 3/8	0.0	0.0	0.0	2	Y
3/8 - 4	0.0	0.0	0.0	2	Y
4 - 8	0.0	0.0	0.0	1	Y
8 - 200	0.0	0.0	0.0	1	Y
200	0.0	0.0	0.0	1	Y

	Size Fraction Between Consecutive Sieves, %			Tolerance, %
Coarse Aggregate:				
	0.0	to	3.0	2
	3.1	to	10.0	3
	10.1	to	20.0	5
	20.1	to	30.0	6
	30.1	to	40.0	7
	40.1	to	50.0	9

3/8 - 4	0.0	0.0	0.0	2	Y
4 - 8	0.0	0.0	0.0	1	Y
8 - 16	0.0	0.0	0.0	1	Y
16 - 30	0.0	0.0	0.0	1	Y
30 - 50	0.0	0.0	0.0	1	Y
50 - 100	0.0	0.0	0.0	1	Y
100 - 200	0.0	0.0	0.0	1	Y
200	0.0	0.0	0.0	1	Y

Fine Aggregate:				
	0.0	to	3.0	1
	3.1	to	10.0	2
	10.1	to	20.0	3
	20.1	to	30.0	4
	30.1	to	40.0	4

Remarks: ____

Distribution______ Central Materials______ Dist. Materials______ Contr./Producer______ Proj. Engineer______ Technician______

HMA GRADATION COMPARISON REPORT

(Computer Spreadsheet Available on Iowa DOT Office of Materials Web Site)

Rev 05/03

Iowa Department Of Transportation

Reported Gradation & IM 216 Comparison Report

Form 201

Project No.: ______________________________

Contract ID: __________________________ Intended Use: ____________________

County: __________________________

Contractor/Producer: __________________________

Mix Design No.: ______________________

Mix Change (Y/N): ________

Date of Change: ________

Total, % Asphalt (Pb): ________

Effective % Asphalt (Pbe): ________

Proper Equipment: ________

Applicable Specs.: ________

	Good	Fair	Poor
Care of Equipment:	_____	_____	_____
Sampling Procedure:	_____	_____	_____
Splitting Procedure:	_____	_____	_____
Sieving to Completion:	_____	_____	_____
Computations:	_____	_____	_____
Reporting:	_____	_____	_____

DOT Tested By: __________________________ Cert. No.: __________ Date: __________

Contr./Prod. Tested By: __________________________ Cert. No.: __________ Date: __________

			Sieve Sizes - Percent Passing											
			1 1/2"	1"	3/4"	1/2"	3/8"	#4	#8	#16	#30	#50	#100	#200
		Specs.												
Sample ID		DOT												
Sample ID		Contr./Prod.												

Sieves	DOT % Retained	Contr./Prod. % Retained	Diff.	Tol. %	Comply (Y/N)
1 1/2 - 1	NA	NA	0.0	2	Y
1 - 3/4	NA	NA	0.0	2	Y
3/4 - 1/2	NA	NA	0.0	2	Y
1/2 - 3/8	NA	NA	0.0	2	Y
3/8 - 4	NA	NA	0.0	2	Y
4 - 8	NA	NA	0.0	2	Y
8 - 16	NA	NA	0.0	2	Y
16 - 30	NA	NA	0.0	2	Y
30 - 50	NA	NA	0.0	2	Y
50 - 100	NA	NA	0.0	2	Y
100 - 200	NA	NA	0.0	2	Y
200	NA	NA	0.0	2	Y

DOT Gyratory Filler/Bitumen Ratio

0.00

Sieve Fraction Between

Consecutive Sieves, %	Tolerance, %
0.0 To 3.0	2
3.1 To 10.0	3
10.1 To 20.0	5
20.1 To 30.0	6
30.1 To 40.0	7
40.1 To 50.0	9

Remarks: ____

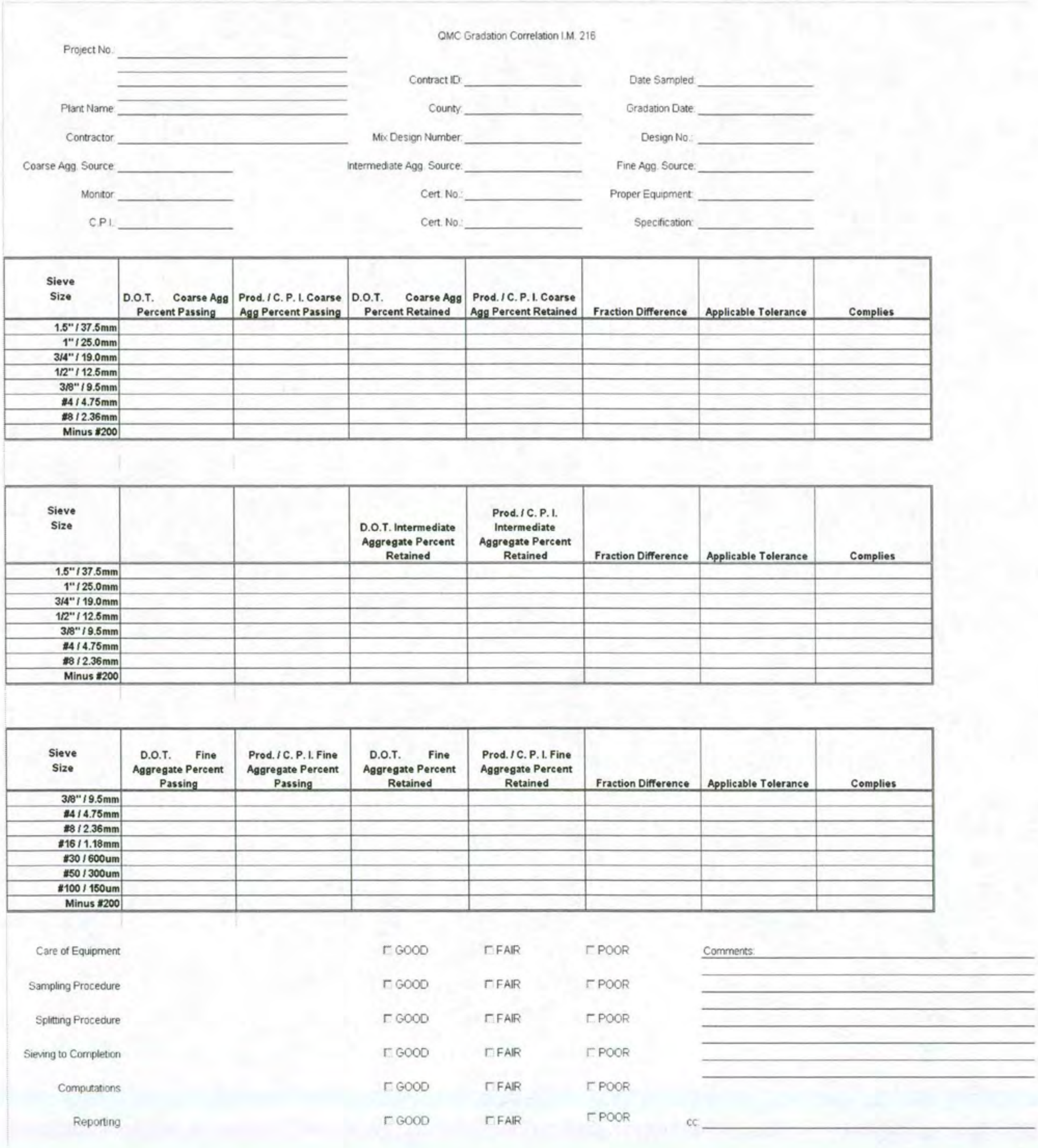
____

____

Distribution_______ Central Materials_______ Dist Materials_______ Contr./Producer_______ Proj. Engineer_______ Technician_______

QMC GRADATION COMPARISON REPORT

(Computer Spreadsheet Available on Iowa DOT Office of Materials Web Site)



QMC Gradation Correlation I.M. 216

Project No.: ____________________

Plant Name: ____________________

Contract ID: ____________

Date Sampled: ____________

County: ____________

Gradation Date: ____________

Contractor: ____________________

Mix Design Number: ____________

Design No.: ____________

Coarse Agg. Source: ____________

Intermediate Agg. Source: ____________

Fine Agg. Source: ____________

Monitor: ____________

Cert. No.: ____________

Proper Equipment: ____________

C.P.I.: ____________

Cert. No.: ____________

Specification: ____________

Sieve Size	D.O.T. Coarse Agg Percent Passing	Prod. / C. P. I. Coarse Agg Percent Passing	D.O.T. Coarse Agg Percent Retained	Prod. / C. P. I. Coarse Agg Percent Retained	Fraction Difference	Applicable Tolerance	Complies
1.5" / 37.5mm							
1" / 25.0mm							
3/4" / 19.0mm							
1/2" / 12.5mm							
3/8" / 9.5mm							
#4 / 4.75mm							
#8 / 2.36mm							
Minus #200							

Sieve Size			D.O.T. Intermediate Aggregate Percent Retained	Prod. / C. P. I. Intermediate Aggregate Percent Retained	Fraction Difference	Applicable Tolerance	Complies
1.5" / 37.5mm							
1" / 25.0mm							
3/4" / 19.0mm							
1/2" / 12.5mm							
3/8" / 9.5mm							
#4 / 4.75mm							
#8 / 2.36mm							
Minus #200							

Sieve Size	D.O.T. Fine Aggregate Percent Passing	Prod. / C. P. I. Fine Aggregate Percent Passing	D.O.T. Fine Aggregate Percent Retained	Prod. / C. P. I. Fine Aggregate Percent Retained	Fraction Difference	Applicable Tolerance	Complies
3/8" / 9.5mm							
#4 / 4.75mm							
#8 / 2.36mm							
#16 / 1.18mm							
#30 / 600um							
#50 / 300um							
#100 / 150um							
Minus #200							

Care of Equipment	☐ GOOD	☐ FAIR	☐ POOR
Sampling Procedure	☐ GOOD	☐ FAIR	☐ POOR
Splitting Procedure	☐ GOOD	☐ FAIR	☐ POOR
Sieving to Completion	☐ GOOD	☐ FAIR	☐ POOR
Computations	☐ GOOD	☐ FAIR	☐ POOR
Reporting	☐ GOOD	☐ FAIR	☐ POOR

Comments: ____________________

cc: ____________________

Iowa Department of Transportation
Office of Materials

April 18, 2006
Supersedes April 30, 2002

Matls. IM 301

AGGREGATE SAMPLING & MINIMUM SIZE OF SAMPLES FOR SIEVE ANALYSIS

SCOPE

This IM sets forth approved sampling methods and the minimum amount of dry materials necessary for the determination of particle size distribution.

LOCATION FOR SAMPLING

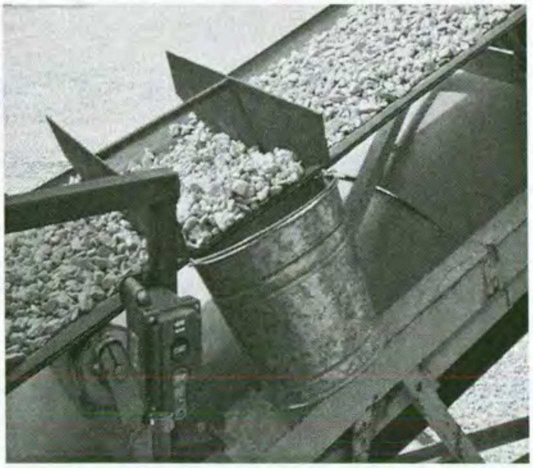
Safety must be foremost when determining sample locations. The Contractor/Producer shall make adequate provisions, satisfactory to the Engineer, for the safety of personnel responsible to obtain representative samples of the aggregate.

Provisions shall include guards for moving belts, pulleys, and wheels near the sampling point, and a stable platform with adequate safety rails when sampling is to be done from an elevated location.

Stopped belt sampling locations must be equipped with an on-off switch near, and in plain view of the sampling location. This switch, when in the off position, must have full control of the belt.

1. Conveyor Belt/Template Method

   To obtain an off-the-belt sample: stop the belt, insert a template (as illustrated in the pictures below) at three or more separate locations along the belt, remove all material within the template, and combine it into the sample. In belt sampling, the ends of the template should be spaced just far enough apart to get an increment approximately one-third the minimum mass (weight) of the sample. If the template does not yield the minimum size of sample in three locations, additional locations will be necessary. No less than three separate locations should be used in obtaining one sample.



2. Stream Flow Method

   When obtaining a sample by interception of the aggregate stream flow, care must be exercised, so the sampling device (See picture below.) passes quickly through the entire stream flow and does not overflow. At least three separate passes shall be made with the sampling device when obtaining a sample. Each pass is an increment of the sample. This is normally considered to be the best method to obtain a representative sample of coarse aggregate.

3. Stockpile Method (for fine aggregate only, or as directed by the District Materials Engineer)

   Stockpile sampling of fine aggregate may be accomplished by either using a shovel or a sand probe. When obtaining a field sample by the stockpile method, a minimum of three increments shall be taken at different locations around the stockpile. Avoid sampling in areas prone to segregation, such as along the bottom of cone stockpiles.

   <u>NOTE:</u> Stockpile sampling of coarse aggregate should be avoided. If it becomes absolutely necessary to obtain a sample from a stockpile, consult the District Materials Engineer to help devise an adequate and proper sampling plan.

SHIPPING SAMPLES

Transport aggregate samples in bags or other containers constructed to preclude loss or contamination of the sample, or damage to the contents from mishandling during shipment.

Shipping containers for aggregate samples shall each have suitable identification attached and enclosed so that field reporting, laboratory logging and testing may be facilitated.

SAMPLE SIZES

Minimum sample sizes for sieve analysis of aggregates are based on the maximum size of the product and the intended use. The following table lists the required minimum field sample and test sample sizes based on the smallest sieve through which at least 95% of the sample will pass.

SIEVE SIZE	FIELD SAMPLE (lbs./kg)	TEST SAMPLE (gms/kg)
1½ in. (37.5 mm)	50/23.0	5,000/5.0[2]
1 in. (25.0 mm)	30/13.5	3,500/3.5
¾ in. (19.0 mm)	20/9.0	2,000/2.0
½ in. (12.5 mm)	20/9.0	1,500/1.5
⅜ in. (9.5 mm)	10/4.5	1,000/1.0[1]
#4 sieve (4.75mm)	10/4.5	500/0.5
#8 sieve (2.36mm)	10/4.5	200/0.2

(Products with maximum sizes over 1½ in. (37.5 mm) are normally visually inspected. Contact the appropriate District Materials Engineer.)

(1) When testing fine aggregate for PC Concrete, the minimum test sample is 500 grams.
(2) When testing 1½" aggregate for Special Backfill, Granular Subbase, or Modified Subbase the minimum test sample is 2500 grams.

Iowa Department of Transportation

Office of Materials

April 8, 2008
Supersedes October 19, 2004

Matls. IM 302

SIEVE ANALYSIS OF AGGREGATES

SCOPE

This method of test covers the procedure for determination of the particle size distribution of aggregates.

PROCEDURE

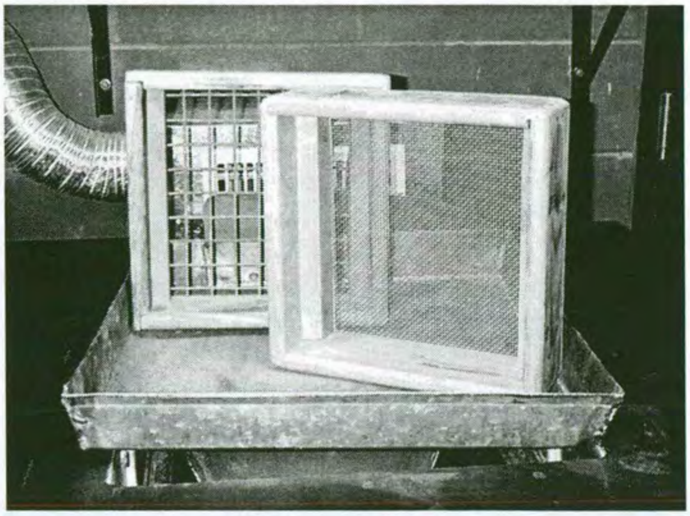
A. Apparatus

1. Balance accurate to within 0.1 percent of weight (mass) of the sample to be tested. **NOTE:** The balance shall be reset to zero before each weighing.

2. Sieves with square openings mounted on substantial frames are constructed in such a manner to prevent loss of material during sieving. Use suitable sieve sizes to furnish the information required by the specifications covering the material to be tested. The woven wire cloth shall conform to AASHTO M-92. This will normally consist of a set of each of the following:

   Box Sieves for testing coarse aggregates consisting of the following sizes:

   37.5 mm (1 1/2-in.)
   25 mm (1-in.)
   19 mm (3/4-in.)
   12.5 mm (1/2-in.)
   9.5 mm (3/8-in.)
   4.75 mm (#4)
   2.36 mm (#8)



203 mm (8 in.) Diameter Sieves for testing fine aggregates consisting of the following sizes:

4.75 mm (#4)	1.18 mm (#16)	150 µm (#100)
2.36 mm (#8)	600 µm (#30)	75 µm (#200)
	300 µm (#50)	Pan

A set of **305 mm (12 in.) Diameter Sieves** may be used for testing fine aggregate or aggregate containing both coarse and fine material.

3. Mechanical and hand-powered sieve shakers

4. Drying oven or stove

5. Fiber bristle sieve cleaning brush (similar to stencil brush or cropped paintbrush)

B. Test Sample

1. Test samples for sieve analysis shall conform to the sample size for the applicable material as indicated by Materials IM 301.

2. Obtain the sample for sieve analysis (test sample) from the material to be tested (field sample) by the appropriate method as outlined in Materials IM 336. The test sample shall be approximately of the weight (mass) desired when dry and must be the end result of the reduction. Reduction to an exact predetermined weight (mass) shall not be permitted.

C. Preparation of Sample

1. When a determination of the amount of material passing the #200 (75 µm) sieve is required, the test sample must first be subjected to Materials IM 306, Determining the Amount of Material Finer Than the #200 (75 µm) Sieve. Coarse aggregates may have a *separate* "wash" sample of the appropriate size (per IM 306) *reduced* from the remaining portion of the field sample, per IM 336.

2. Coarse aggregates, which have changes in moisture for different particle sizes, must be dried to a constant weight (mass). When the absorbed moisture stays essentially the same for different particle sizes the sample may be sieved at a surface-dry condition (no free water present).

   NOTE: Material from crushed composite (HMA/PC) pavements shall be sieved at a surface-dry condition using no artificial heat. No gradation determination will be made for material finer than the #8 (2.36 mm) sieve. For material made from crushed PC pavement, determination of the percent passing the #200 sieve may be required. In some instances, larger particles may be coated to the extent that dry sieving will not accurately reflect the true gradation of the material. In these instances, the air-dried sample must be washed over the #8 (2.36 mm) sieve and allowed to come to a surface-dry condition by air-drying. The total percent passing this sieve is the sum of the washing loss and pan after dry sieving divided by the original (air) dry/weight (mass). Coated particles may also be a problem with some virgin aggregate material (e.g., Class D crushed stone, etc.). When this condition exists, the material shall be dried to a constant weight (mass), washed over the smallest sieve for which there is a specification requirement, and dried again. The total percentage passing this sieve is a combination of the washing loss and the amount passing the sieve obtained by dry sieving the washed sample divided by the original dry weight (mass).

D. Test Procedure

1. Weigh and record the weight (mass) of the test sample as the Original Dry Mass.

2. Sieve the sample over the required sieves. The sieving operation must be accomplished by using a lateral and vertical motion of the sieve(s), accompanied by a jarring action, which keeps the sample moving continuously over the surface of the sieve. Do not attempt to turn or manipulate the aggregate particle through the sieve openings by hand.

   When using a mechanical sieve shaker, excessive sieving times may result in degradation of the sample.

   The sieving operation may be considered complete when not more than 0.5 percent by weight (mass) of the original sample passes any sieve during an additional one minute of hand-sieving.

   a. On the #4 (4.75 mm) and larger sieves, limit the amount of material carried on the sieve to a single layer when determining sieving to completion.

b. Overloading of the 8 in. (203 mm) and 12 in. (305 mm diameter sieves, #4 (4.75 mm) and smaller, must be avoided to allow for sieving to completion. The weights retained should not exceed the following:

8 in. (203 mm) diameter sieves	12 in. (305mm) diameter sieves
#4 (4.75 mm) 200 grams and smaller	#4 (4.75 mm) 850 grams #8 (2.36mm) 450 grams and smaller

If sieving to completion (as described above) is not readily accomplished, reduce the amount of material carried on the sieve.

c. When the aggregate being tested has a mixture of coarse and fine material, the portion of the sample finer than the #4 (4.75 mm) sieve may be distributed among two or more sets of sieves to prevent overloading of individual sieves. Alternately, the portion passing the #4 (4.75 mm) sieve may be reduced to a minimum of 500 grams using a mechanical splitter according to IM 336. If this procedure is followed, compute the weight (mass) of each size increment of the original sample as follows:

$$A = \frac{W1}{W2} \times B$$

Where:

A = calculated weight (mass) of the material retained on each sieve based on the total sample weight (mass).

W1 = weight (mass) of the total amount of material passing the #4 (4.75 mm) sieve.

W2 = weight (mass) of the reduced, minus #4 (4.75 mm) sieve material.

B = weight (mass) of the reduced sample material retained on each sieve.

NOTE: This method is recommended when using 8 in. (203 mm) diameter sieves to test the fine aggregate portion of a sample when overload is anticipated. If using 12 in. (305 mm) sieves and the original test sample is reasonably close to the required weight (mass), overload should not occur. When sieve overload is anticipated on the #8 (2.36 mm) sieve only, sieve the original sample through the #8 (2.36 mm) box sieve before placing the fine portion in the nest of 8 in. (203 mm) round sieves.

3. Clean the retained material from each sieve for weighing. Remove as much material as practical without damaging the wire cloth. Particles may be removed most readily from a sieve by inverting the sieve over a pan and tapping the sieve by hand and/or pushing (without force) the particles out of the mesh into the pan. Care must be taken while cleaning the sieves, so no damage occurs to the wire mesh by bending or breaking the wires. A fiber-bristle brush should be used for cleaning the #16 (1.18 mm), #30 (600 µm), and #50 (300 µm) sieves. Do not use a brush or any external force on the wire cloth to attempt cleaning the #100 (150 µm), or #200 (75 µm) sieves. If clogging of the mesh occurs on these finer sieves, they should be sent to the District Materials Laboratory for cleaning.

4. Weight the fraction of material retained on each sieve and in the pan, to at least the nearest 0.5 gram and record. Total the weight (mass) of the material retained on the sieves and in the pan.

5. An accuracy check must be made comparing the weight (mass) of the material before sieving to the total weight (mass) after sieving. The total of the weights retained on the sieves and in the pan must be within 0.5 percent of the Original Dry Mass by washing.

   When the percent finer than the #200 (75µm) sieve is <u>not</u> determined:

$$\frac{\text{Total}}{\text{Original Dry Mass}} \quad \text{X} \quad 100 = \text{Tolerance (99.5 to 100.5)}$$

   When the percent finer than the #200 (75 µm) sieve is determined by washing (IM 306):

$$\frac{\text{Total - Washing Loss}}{\text{Dry Mass Washed}} \quad \text{X} \quad 100 = \text{Tolerance (99.5 to 100.5)}$$

   If the difference exceeds the 0.5 percent tolerance, check all the calculations, the sieves for retained material and the balance for proper care. If needed, weigh each increment of material retained again. If the error cannot be found, the test is void and a new sample shall be tested.

E. Calculations

1. Divide the weight (mass) of the material retained on each sieve, and in the pan, by the Original Dry Weight (mass) of the sample. When computing the percent retained of a **washed** sample the sum of the washing loss and pan weight (mass) shall be divided by the Original Dry Weight (mass). Computation shall be carried out to the nearest 0.1 percent when determining percent retained and the consequent percent passing.

2. The percent-retained column should equal 100 percent when totaled. Because the weight (mass) of material retained on the sieves may not equal the Original Dry Weight (mass), the total of the percentages retained may not equal 100 percent. If this occurs, the percentages retained should be altered by prorating on the larger quantities, so they do equal 100 percent.

3. The percent passing is then determined by subsequent subtraction starting with the sieve which had no material retained (100 percent passing).

4. Sieve analysis results are to be reported in terms of percent passing and recorded to two significant figures, i.e., to the nearest whole percent for percentages above 10.0 and to the nearest tenth of a percent for lower results.

5. The fineness Modulus, when required, may now be calculated by cumulative addition of the percent retained on each of the following sieves coarser than the 75 µm (#200) sieve and dividing that sum by 100: 150 µm (#100); 300 µm (#50); 600 µm (#30); 1.18 mm (#16); 2.36 mm (#8); 4.75 mm (#4); 9.5 mm (3/9 in.); 19.0 mm (3/4 in.); 37.5 mm (1 ½ in.), and larger, (i.e. doubling the previous sieve size).

IOWA DEPARTMENT OF TRANSPORTATION
SIEVE ANALYSIS WORKSHEET

EXAMPLE #1, COARSE AGGREGATE

Lab. No.:			
Material:		Grad. No.:	
Co. & Proj. #:			
Producer:			
Contractor:			
Sampled By:		Date:	
Sample Loc.:			

Original Dry Mass:	5793	Total Minus 4.75 mm (W1):	
Dry Mass Washed:		Reduced Minus 4.75 mm (W2):	
Washing Loss:		Conversion Factor: W1 / W2	
		Calculated Weight (A)=Conversion Factor x (B)	

Sieve Size	Reduced Minus 4.75mm	Total or Calc. Weight Retd	% Retd.	% Passing	Specs.
37.5mm (1½)	▨			100.0	
25mm (1)	▨	577	10.0	90.0	
19mm (¾)	▨	1068	18.4	71.6	
12.5mm (½)	▨	1446	25.0	46.6	
9.5mm (3/8)	▨	1383	23.9	22.7	
4.75mm (4)	▨	1082	18.7	4.0	
2.36mm (8)	(B)	141 (A)	2.4	1.6	
1.18mm (16)	(B)	(A)			
600µm (30)	(B)	(A)			
300µm (50)	(B)	(A)			
150µm (100)	(B)	(A)			
75µm (200)	(B)	(A)		0.8	
Wash	▨	(A)	1.6		
Pan	(B)	93 (A)			
Total		5790	100.0		
Tolerance		99.9			

Wash Sample

Original Dry Mass:	2571.0
Dry Mass Washed:	2555.0
Washing Loss:	16.0

Sieve Size	Mass Retd.	% Retd.	% Passing	Specs.
75µm (200)			0.8	
Wash	16.0	0.8		
Pan	4.0			

Date Reported:	Cert. No.:	
Tested By:		

Note: For the 4.75mm (#4) sieve and smaller, a 203mm (8") sieve should retain no more than 200 grams, and a 305mm (12") sieve no more than 450 grams

Comments: ____

Lab. No.:			
Material:		Grad. No.:	
Co. & Proj. #:			
Producer:			
Contractor:			
Sampled By:		Date:	
Sample Loc.:			

Original Dry Mass:		Total Minus 4.75 mm (W1):	
Dry Mass Washed:		Reduced Minus 4.75 mm (W2):	
Washing Loss:		Conversion Factor: W1 / W2	
		Calculated Weight (A)=Conversion Factor x (B)	

Sieve Size	Reduced Minus 4.75mm	Total or Calc. Weight Retd	% Retd.	% Passing	Specs.
37.5mm (1½)	▨				
25mm (1)	▨				
19mm (¾)	▨				
12.5mm (½)	▨				
9.5mm (3/8)	▨				
4.75mm (4)	▨				
2.36mm (8)	(B)	(A)			
1.18mm (16)	(B)	(A)			
600µm (30)	(B)	(A)			
300µm (50)	(B)	(A)			
150µm (100)	(B)	(A)			
75µm (200)	(B)	(A)			
Wash	▨				
Pan	(B)	(A)			
Total					
Tolerance					

Wash Sample

Original Dry Mass:	
Dry Mass Washed:	
Washing Loss:	

Sieve Size	Mass Retd.	% Retd.	% Passing	Specs.
75µm (200)				
Wash				
Pan				

Date Reported:	Cert. No.:	
Tested By:		

Note: For the 4.75mm (#4) sieve and smaller, a 203mm (8") sieve should retain no more than 200 grams, and a 305mm (12") sieve no more than 450 grams

Comments: ____

IOWA DEPARTMENT OF TRANSPORTATION
SIEVE ANALYSIS WORKSHEET

EXAMPLE #2, FINE AGGREGATE

Lab. No.:			
Material:		Grad. No.:	
Co. & Proj. #:			
Producer:			
Contractor:			
Sampled By:		Date:	
Sample Loc.:			

Original Dry Mass:	594.0	Total Minus 4.75 mm (W1):	
Dry Mass Washed	591.5	Reduced Minus 4.75 mm (W2):	
Washing Loss:	2.5	Conversion Factor: W1 / W2	
		Calculated Weight (A)=Conversion Factor x (B)	

Sieve Size	Reduced Minus 4.75mm	Total or Calc. Weight Retd	% Retd.	% Passing	Specs.
37.5mm (1½)					
25mm (1)					
19mm (¾)					
12.5mm (½)					
9.5mm (3/8)				100.0	
4.75mm (4)		29.0	4.9	95.1	
2.36mm (8)	(B)	64.5 (A)	10.9	84.2	
1.18mm (16)	(B)	102.0 (A)	17.2	67.0	
600µm (30)	(B)	181.5 (A)	30.6 (30.7)	36.3	
300µm (50)	(B)	154.5 (A)	26.0 (26.1)	10.2	
150µm (100)	(B)	51.0 (A)	8.6	1.6	
75µm (200)	(B)	6.0 (A)	1.0	0.6	
Wash		2.5	0.6		
Pan	(B)	1.0 (A)			
Total		592.0	99.8 (100.0)		
Tolerance		99.7			

Wash Sample	Original Dry Mass:	
	Dry Mass Washed:	
	Washing Loss:	

Sieve Size	Mass Retd.	% Retd.	% Passing	Specs.
75µm (200)				
Wash				
Pan				

Date Reported:	Cert. No.:
Tested By:	

Note: For the 4.75mm (#4) sieve and smaller, a 203mm (8") sieve should retain no more than 200 grams, and a 305mm (12") sieve no more than 450 grams

Comments: ______________________________

Lab. No.:			
Material:		Grad. No.:	
Co. & Proj. #:			
Producer:			
Contractor:			
Sampled By:		Date:	
Sample Loc.:			

Original Dry Mass:		Total Minus 4.75 mm (W1):	
Dry Mass Washed:		Reduced Minus 4.75 mm (W2):	
Washing Loss:		Conversion Factor: W1 / W2	
		Calculated Weight (A)=Conversion Factor x (B)	

Sieve Size	Reduced Minus 4.75mm	Total or Calc. Weight Retd	% Retd.	% Passing	Specs.
37.5mm (1½)					
25mm (1)					
19mm (¾)					
12.5mm (½)					
9.5mm (3/8)					
4.75mm (4)					
2.36mm (8)	(B)	(A)			
1.18mm (16)	(B)	(A)			
600µm (30)	(B)	(A)			
300µm (50)	(B)	(A)			
150µm (100)	(B)	(A)			
75µm (200)	(B)	(A)			
Wash					
Pan	(B)	(A)			
Total					
Tolerance					

Wash Sample	Original Dry Mass:	
	Dry Mass Washed:	
	Washing Loss:	

Sieve Size	Mass Retd.	% Retd.	% Passing	Specs.
75µm (200)				
Wash				
Pan				

Date Reported:	Cert. No.:
Tested By:	

Note: For the 4.75mm (#4) sieve and smaller, a 203mm (8") sieve should retain no more than 200 grams, and a 305mm (12") sieve no more than 450 grams

Comments: ______________________________

IOWA DEPARTMENT OF TRANSPORTATION
SIEVE ANALYSIS WORKSHEET

EXAMPLE #3, COMBINED AGGREGATE, 8" AND BOX SIEVES

Lab. No.:		
Material:		Grad. No.:
Co. & Proj. #:		
Producer:		
Contractor:		
Sampled By:	Date:	
Sample Loc.:		

Original Dry Mass:	2457.2	Total Minus 4.75 mm (W1):	2115.7
Dry Mass Washed:	2410.5	Reduced Minus 4.75 mm (W2):	537.2
Washing Loss:	46.7	Conversion Factor: W1 / W2	3.9384
		Calculated Weight (A)=Conversion Factor x (B)	

Sieve Size	Reduced Minus 4.75mm	Total or Calc. Weight Retd	% Retd.	% Passing	Specs.
37.5mm (1½)	▨				
25mm (1)	▨			100.0	
19mm (¾)	▨	14.6	0.6	99.4	
12.5mm (½)	▨	45.9	1.9	97.5	
9.5mm (3/8)	▨	81.0	3.3	94.2	
4.75mm (4)	▨	154.0	6.3	87.9	
2.36mm (8)	57.6 (B)	226.9 (A)	9.2	78.7	
1.18mm (16)	93.0 (B)	366.3 (A)	14.9	63.8	
600µm (30)	178.3 (B)	694.3 (A)	28.3 (28.4)	35.4	
300µm (50)	172.5 (B)	679.4 (A)	27.6	7.8	
150µm (100)	32.7 (B)	128.8 (A)	5.2	2.6	
75µm (200)	3.9 (B)	15.4 (A)	0.6	2.0	
Wash	▨	46.7	2.0		
Pan	0.8 (B)	3.2 (A)			
Total	536.8	2456.5	99.9 (100.0)		
Tolerance	99.9	100.0			

Wash Sample	Original Dry Mass:	
	Dry Mass Washed:	
	Washing Loss:	

Sieve Size	Mass Retd.	% Retd.	% Passing	Specs.
75µm (200)				
Wash				
Pan				

Date Reported:	Cert. No.:	
Tested By:		

Note: For the 4.75mm (#4) sieve and smaller, a 203mm (8") sieve should retain no more than 200 grams, and a 305mm (12") sieve no more than 450 grams

Comments: ______________________

Lab. No.:		
Material:		Grad. No.:
Co. & Proj. #:		
Producer:		
Contractor:		
Sampled By:	Date:	
Sample Loc.:		

Original Dry Mass:		Total Minus 4.75 mm (W1):	
Dry Mass Washed:		Reduced Minus 4.75 mm (W2):	
Washing Loss:		Conversion Factor: W1 / W2	
		Calculated Weight (A)=Conversion Factor x (B)	

Sieve Size	Reduced Minus 4.75mm	Total or Calc. Weight Retd	% Retd.	% Passing	Specs.
37.5mm (1½)	▨				
25mm (1)	▨				
19mm (¾)	▨				
12.5mm (½)	▨				
9.5mm (3/8)	▨				
4.75mm (4)	▨				
2.36mm (8)	(B)	(A)			
1.18mm (16)	(B)	(A)			
600µm (30)	(B)	(A)			
300µm (50)	(B)	(A)			
150µm (100)	(B)	(A)			
75µm (200)	(B)	(A)			
Wash	▨				
Pan	(B)	(A)			
Total					
Tolerance					

Wash Sample	Original Dry Mass:	
	Dry Mass Washed:	
	Washing Loss:	

Sieve Size	Mass Retd.	% Retd.	% Passing	Specs.
75µm (200)				
Wash				
Pan				

Date Reported:	Cert. No.:	
Tested By:		

Note: For the 4.75mm (#4) sieve and smaller, a 203mm (8") sieve should retain no more than 200 grams, and a 305mm (12") sieve no more than 450 grams

Comments: ______________________

IOWA DEPARTMENT OF TRANSPORTATION
SIEVE ANALYSIS WORKSHEET

EXAMPLE #4, COMBINED AGGREGATE, 12" SIEVES

Lab. No.:		
Material:		Grad. No.:
Co. & Proj. #:		
Producer:		
Contractor:		
Sampled By:	Date:	
Sample Loc.:		

Original Dry Mass:	2051.2	Total Minus 4.75 mm (W1):	
Dry Mass Washed:	2011.4	Reduced Minus 4.75 mm (W2):	
Washing Loss:	39.8	Conversion Factor: W1 / W2	
		Calculated Weight (A)=Conversion Factor x (B)	

Sieve Size	Reduced Minus 4.75mm	Total or Calc. Weight Retd	% Retd.	% Passing	Specs.
37.5mm (1½)					
25mm (1)				100.0	
19mm (¾)		26.8	1.3	98.7	
12.5mm (½)		80.7	3.9	94.8	
9.5mm (3/8)		55.1	2.7	92.1	
4.75mm (4)		182.7	8.9	83.2	
2.36mm (8)	(B)	229.7 (A)	11.2	72.0	
1.18mm (16)	(B)	362.8 (A)	17.7	54.3	
600µm (30)	(B)	610.5* (A)	29.8	24.5	
300µm (50)	(B)	377.1 (A)	18.4	6.1	
150µm (100)	(B)	72.2 (A)	3.5	2.6	
75µm (200)	(B)	10.2 (A)	0.5	2.1	
Wash		39.8	2.1		
Pan	(B)	3.4 (A)			
Total		2051.0	100.0		
Tolerance		100.0			

Wash Sample	Original Dry Mass:	
	Dry Mass Washed:	
	Washing Loss:	

Sieve Size	Mass Retd.	% Retd.	% Passing	Specs.
75µm (200)				
Wash				
Pan				

Date Reported:	Cert. No.:
Tested By:	

Note: For the 4.75mm (#4) sieve and smaller, a 203mm (8") sieve should retain no more than 200 grams, and a 305mm (12") sieve no more than 450 grams

Comments: *The 600µm (30) sieve was overloaded. Sieving to completion was verified by hand sieving.

Lab. No.:		
Material:		Grad. No.:
Co. & Proj. #:		
Producer:		
Contractor:		
Sampled By:	Date:	
Sample Loc.:		

Original Dry Mass:		Total Minus 4.75 mm (W1):	
Dry Mass Washed:		Reduced Minus 4.75 mm (W2):	
Washing Loss:		Conversion Factor: W1 / W2	
		Calculated Weight (A)=Conversion Factor x (B)	

Sieve Size	Reduced Minus 4.75mm	Total or Calc. Weight Retd	% Retd.	% Passing	Specs.
37.5mm (1½)					
25mm (1)					
19mm (¾)					
12.5mm (½)					
9.5mm (3/8)					
4.75mm (4)					
2.36mm (8)	(B)	(A)			
1.18mm (16)	(B)	(A)			
600µm (30)	(B)	(A)			
300µm (50)	(B)	(A)			
150µm (100)	(B)	(A)			
75µm (200)	(B)	(A)			
Wash					
Pan	(B)	(A)			
Total					
Tolerance					

Wash Sample	Original Dry Mass:	
	Dry Mass Washed:	
	Washing Loss:	

Sieve Size	Mass Retd.	% Retd.	% Passing	Specs.
75µm (200)				
Wash				
Pan				

Date Reported:	Cert. No.:
Tested By:	

Note: For the 4.75mm (#4) sieve and smaller, a 203mm (8") sieve should retain no more than 200 grams, and a 305mm (12") sieve no more than 450 grams

Comments:

Fineness Modulus Calculation
For Concrete Sand (Grad. #1 – Spec. 4110)
AASHTO T27

Iowa DOT has specified that sand produced for the use in Portland Cement Concrete should have a Fineness Modulus of 2.75 or higher. The Materials Engineer may require samples be submitted for Mortar Strength testing if the Fineness Modulus fails to meet the minimum 2.75.

The Fineness Modulus is simply a calculation based on the 'cumulative' percent retained from the sieve analysis sample.

Starting with the largest sieve retaining any material, add the cumulative percents retained on each sieve through the #100 sieve and divide this total by 100. The result is reported to the nearest 0.01%.

Note: The percent retained on the #200 sieve is not calculated in determining the Fineness Modulus.

Example:

Sieve	Percent Retained	Cumulative Percent Retained
3/8"	0	0
#4	3.6	3.6
#8	16.9	20.5
#16	19.6	40.1
#30	23.4	63.5
#50	26.1	89.6
#100	9.5	99.1

Total Cumulative Percent Retained = 316.4

316.4 ÷ 100 = 3.16 Fineness Modulus

DETERMINING THE AMOUNT OF MATERIAL FINER THAN THE #200 (75 µm) SIEVE IN AGGREGATE

SCOPE

This test method outlines the procedure for determining the quantity of material finer than a #200 (75 µm) sieve by washing and dry sieving.

PROCEDURE

A. Apparatus

1. A #200 (75 µm) sieve (wash sieve)
2. A wash pan large enough to prevent loss of water and material
3. Oven or drying stove
4. Balance accurate to 0.1 percent of the sample mass (weight)
5. A set of 8-in. (203-mm) or 12-in. (305-mm) sieves for dry sieving

B. Test Sample

1. Select the test sample from the material to be tested by an appropriate method as outlined in Materials IM 336.
2. When determination of specification compliance is needed on each or any of the following sieves: #16 (1.18 mm), #30 (600 µm), #50 (300 µm), or #100 (150 µm), subject the entire sample to this test procedure.
3. When determination of specification compliance is needed for only the amount of material finer than the #200 (75 µm) sieve, reduce the remaining portion of the field sample from which the original test sample was selected, by the appropriate method as outlined in IM 336. A representative sample, sufficient to yield not less than the appropriate mass of dried material, as shown in the following table shall be selected:

Sieve Analysis Sample Mass (Weight) kg (See Materials IM 301)	Appropriate Minimum Mass (Weight) kg of Sample
5.0 kg	2.5 kg
3.5 kg	2.5 kg
2.0 kg	1.0 kg
1.5 kg	*
1.0 kg	*
0.5 kg	*
0.2 kg	*

*Use entire sample.

C. Test Procedure

1. Place the sample in the oven at 230˚F (110˚C) or on the stove and dry to a constant mass (weight). Care must be taken in drying the sample to avoid overheating causing the sample to "pop" or "sputter."

2. Allow the sample to cool, weigh and record as the Original Dry Mass (Weight).

3. Place the sample in the wash pan and add a sufficient amount of water to cover it. A detergent, dispersing agent, or other wetting solution may be added to the water to ensure a thorough separation of fine material from the coarser particles.

4. Agitate the sample vigorously using a rotary motion of the pan for five to ten seconds.

5. Pour off the water through the #200 (75 µm) wash sieve. When washing samples with a high silt content, it may be necessary to vibrate or lightly tap the wash sieve in order to keep the mesh open so the water and the minus #200 (75 µm) sieve material may pass through freely. Repeat this operation until the wash water appears almost clear.

6. Rinse the material retained on the #200 (75 µm) sieve back into the sample and decant as much water as possible by carefully pouring the water through the #200 (75 µm) sieve.

7. Dry the washed sample, allow to cool, weigh and record as the Dry Mass (Weight) of the washed sample.

8. When determining only the amount passing the #200 (75 µm) sieve, screen the sample over the #8 (2.36 mm) sieve and discard the retained material. Place the portion of material passing the #8 (2.36 mm) sieve on a nest of sieves including the #50 (300 µm), #100 (150 µm), and #200 (75 µm) sieves and the pan. The sieves larger than the #200 (75 µm) sieve are included for protection of the #200 (75 µm) sieve. Place the nest of sieves in the mechanical sieve shaker and sieve to completion (normally five minutes or less). Weigh and record only the material retained in the pan.

9. When a complete sieve analysis is required, test the entire sample using the appropriate method as outlined in IM 302.

D. Calculations

$$\text{\% Passing 75 µm (\#200) sieve} = \frac{\text{Washing Loss + Pan}}{\text{Original Dry Mass (Weight)}} \times 100$$

DETERMINING SPECIFIC GRAVITY OF AGGREGATES

SCOPE

This method describes two procedures used for determining the bulk specific gravity of aggregates proposed for use in Portland Cement Concrete. This method is also described in Laboratory Test Method 201.

PROCEDURE A – SPECIFIC GRAVITY OF AGGREGATES USING A PYCNOMETER

A. Apparatus

1. Balance having a capacity of at least 5,000 grams, accurate to 0.5 grams
2. Pycnometer – a fruit jar supplied with a gasket and conical pycnometer top. A two-quart pycnometer is used for coarse aggregates, and a one-quart pycnometer is used for fine aggregate. If a two-quart pycnometer cannot be obtained, a one-quart jar may be substituted (The engineer may require 2 samples be obtained and tested in separate 1-quart pycometers for some aggregates). The quantity of aggregate would be approximated 1100 grams for the one-quart pycnomter.
3. Thermometer – a thermometer with a range of at least 50°F (10°C) to 100°F (38°C)
4. Sieve – a No. 4 (4.75 mm) sieve

B. Field Sample

1. Obtain a field sample as prescribed in IM 301.

C. Preparation of Test Sample

1. Fine Aggregate
    a. Obtain a test sample of approximately 1100 grams from the material to be tested by one of the following methods:
        (1) Use of a sample splitter
        (2) Method of quartering after being thoroughly mixed and in a damp condition
        (3) By taking small scoops of material from various places over the field sample, after it has been dampened and thoroughly mixed. In order to avoid segregation, the material must be damp enough to stand in a vertical face when cut with a trowel. This method of sample reduction is applicable to sands only.

b. If the material has been continuously wet before being received on the job, it may be assumed to be saturated. Otherwise, the sample must be saturated by immersing it in water for period of not less than 15 hours.

c. After soaking, pour off the free water, spread the wet sample on a flat, non-absorbent surface, and allow it to come to a surface-dry condition by natural evaporation of free moisture. Circulation of air by means of a fan may also be used to attain the surface-dry condition. The sample should be stirred frequently to secure uniform drying.

2. Coarse Aggregate

a. Obtain the test sample as prescribed in IM 336, Methods of Reducing Aggregate Field Samples To Test Samples (See Sections on Quartering or Splitting).

b. Sieve the test sample over the No. 4 (4.75 mm) sieve. The sample should be of sufficient size to produce approximately 2100 grams of material retained on the No. 4 sieve. Discard the material that passes this sieve.

c. Immerse the sample (plus No. 4 sieve size) in water for a period of not less than 15 hours.

d. After soaking, pour off the free water and allow the sample to come to a saturated-surface-dry condition by spreading the sample on a flat, non-absorbent surface. The forced circulation of air by means of a fan, if available, may hasten this process. The sample should be stirred frequently to secure uniform drying. The predominance of free moisture may be removed initially by rolling the sample back and forth in a clean, dry, absorbent cloth.

e. The sample may be considered to be saturated-surface-dry when the particles look comparatively dull as the free moisture is removed from their surfaces. For highly absorptive aggregates, the saturated-surface-dry condition is reached when there is an absence of free moisture.

D. Calibration of Pycnometers

1. Fill the pycnometer jar nearly full of water at the temperature to be used in the actual test, plus or minus 3°F (1.7°C). This may be done either before or after the actual test.

2. Screw the pycnometer top down tightly on the jar and mark the position of the top on the jar by a scratch or mark on the threaded rim and a scratch in a corresponding position on the jar, which will establish a constant volume.

3. Fill the pycnometer completely by pouring water into the hole of the pycnometer top until a bead forms above the opening. Immediately wipe the bead of water level with the pycnometer opening. Wipe all other excess moisture from the outside surfaces of the pycnometer. If a bead of water forms at the opening during the final wiping, it should remain for weighing. Weigh the pycnometer to the nearest 0.5-gram.

E. Test Procedure

1. Weigh the saturated-surface-dry sample to the nearest 0.5-gram. For ease in calculations, the fine aggregate sample may be brought to exactly 1000 grams weight, and the coarse aggregate sample may be brought to exactly 2000 grams weight.

2. Place the sample in the appropriate pycnometer containing approximately two inches of water.

3. Nearly fill the pycnometer jar with water at the same temperature plus or minus 3°F (1.7°C) as used in the calibration.

4. Screw the cap down into the proper position by lining up the mark on the pycnometer top and the jar.

5. Entirely fill the pycnometer by adding additional water through the hole in the pycnometer top.

6. Hold one finger over the hole in the top and gently roll and shake the pycnometer to remove any trapped air in the sample.

7. When further rolling and shaking brings no more air bubbles to the top, fill, dry and weigh as in step C3.

F. Calculations

1. Calculate the saturated-surface-dry (SSD) specific gravity to the nearest 0.01 by the following formula:

$$\text{Bulk Specific Gravity (SSD)} = \frac{S}{P + S - W}$$

Where:

S = Weight in grams of aggregate in a saturated-surface-dry condition.

P = Weight in grams of the pycnometer filled with water.

W = Weight in grams of the pycnometer containing the sample and sufficient water to fill the remaining space in the pycnometer.

Pycnometers for Coarse and Fine Aggregates

PROCEDURE B – SPECIFIC GRAVITY OF COARSE AGGREGATE (AASHTO T 85)

A. Apparatus

1. Balance having a capacity of at least 5,000 grams, accurate to 0.5 grams

2. Sample Container – A wire basket of No. 6 (3.35 mm) or finer mesh, or a bucket of approximately equal breadth and height, with a capacity of 4 to 7 L. The container shall be constructed so as to prevent trapping air when the container is submerged.

3. Water Tank – A watertight tank, into which the sample and container are placed for complete immersion while suspended below the balance, equipped with an overflow outlet for maintaining a constant water level.

4. Suspended Apparatus – Wire suspending the container shall be of the smallest practical size to minimize any possible effects of a variable immersed length.

5. Sieve - A No. 4 (4.75 mm) sieve

6. Thermometer – a thermometer with a range of 50°F (10°C) to 100°F (38°C)

B. Field Sample

1. Obtain a field sample as prescribed in IM 301.

C. Preparation of Test Sample

1. Prepare the test sample identical to that described in Procedure A.

D. Test Procedure

1. Weigh the saturated-surface-dry sample to the nearest 0.5-gram. For ease in calculations, the fine aggregate sample may be brought to exactly 1000 grams weight, and the coarse aggregate sample may be brought to exactly 2000 grams weight.

2. After weighing, immediately place the saturated-surface-dry sample in the sample container, remove all entrapped air by shaking the immersed container, and determine its mass in water at 73.4°F ± 3°F (23.0°C ± 1.7°C). Make sure the water is at a depth sufficient enough to cover the container and sample.

E. Calculations

1. Calculate the saturated-surface-dry (SSD) specific gravity to the nearest 0.01 by the following formula:

$$\text{Bulk Specific Gravity (SSD)} = \frac{S}{S - W}$$

Where:

S = Weight in grams of aggregate in a saturated-surface-dry condition.
W = Weight in grams of the saturated-surface-dry sample in water

Iowa Department of Transportation

Office of Materials

October 19, 2004
Supersedes October 29, 2002

Matls. IM 308

DETERMINING FREE MOISTURE & ABSORPTION OF AGGREGATES

SCOPE

This method describes several procedures for determining free moisture and absorption of aggregates.

PROCEDURE A - FREE MOISTURE IN AGGREGATES USING A PYCNOMETER

A. Apparatus

1. Balance having a capacity of at least 5,000 grams accurate to 0.5 grams
2. Pycnometer - A fruit jar supplied with a gasket and conical pycnometer top. A two-quart pycnometer is used for coarse aggregates. If a two-quart pycnomter cannot be obtained, a one-quart jar may be substituted (The engineer may require 2 samples be obtained and tested in separate 1-quart pycnometers for some aggregates). The quantity of aggregate would be approximately 1000 grams for the one-quart pycnomter. A one-quart pycnometer is used for fine aggregates.
3. Thermometer - -35°C (-30°F) to 50°C (120°F) thermometer
4. Scoop

B. Field Sample

1. Obtain a field sample as prescribed in IM 301.

C. Preparation of Test Sample

1. Obtain a test sample of about 1000 grams of fine aggregate or about 2000 grams of coarse aggregate by the following method:

   Place the field sample on a clean, hard non-absorbent surface. Mix the sample thoroughly, form a miniature stockpile and obtain small increments of materials from random locations from the stockpile until the desired sample size is obtained. **NOTE:** The moisture test should be completed as soon as possible after obtaining the field sample to avoid moisture loss due to evaporation.

2. Weigh to the nearest 0.5-gram, a 1000-gram sample of fine aggregate, or 2000-gram sample of coarse aggregate. To avoid moisture loss due to evaporation the weighing should be done immediately after obtaining the test sample. Also avoid any excessive manipulation of the aggregate, prior to weighing, which could cause a loss of moisture.

D. Calibration of Pycnometer

1. Calibrate the pycnometer by the procedure in IM 307.

E. Test Procedure

1. The test procedure is identical to IM 307 with the exception that the test sample is wet, as received, and not in a saturated surface dry condition. This procedure is intended for determining the moisture content of aggregates for Portland Cement Concrete.

F. Calculation

1. Calculate the moisture content, based on wet sample mass (weight), to the nearest 0.1 percent as follows:

$$\text{Percent Moisture as received} = \frac{(W - W_1)Gs \times 100}{(Gs - 1)s}$$

Where:

W = Mass (Weight) in grams of the pycnometer containing a saturated-surface-dry sample of the same mass (weight) as "s" and sufficient water to fill the remaining volume of the pycnometer as determined in IM 307.

W_1 = Mass (Weight) in grams of the pycnometer containing the wet sample and sufficient amount of water to fill the remaining volume of the pycnometer.

Gs = Specific gravity of material in a saturated-surface-dry condition. (This is obtained from Method IM 307.

s = Mass (Weight) in grams of wet sample

2. The percent of moisture, based on the saturated-surface-dry mass (weight), is calculated as follows:

$$\text{Percent Moisture (SSD)} = \frac{\%\text{Moisture as received}}{100 - \%\text{Moisture as received}} \times 100$$

<u>PROCEDURE B – FREE MOISTURE IN AGGREGATE BY MASS (WEIGHT) DIFFERENCE</u>

This procedure is an alternate to using a pycnometer and is also intended for determining the moisture content of aggregates for Portland Cement Concrete.

A. Apparatus

1. Balance having a capacity of at least 5,000 grams and accurate to 0.5 gram

B. Preparation of Sample

1. Prepare the test sample identical to that described in Procedure A.

C. Test Procedure

1. Bring the weighed wet sample to a saturated-surface-dry condition in the manner described in Materials IM 307 and weigh to the nearest 0.5 gram.

D. Calculation

1. Calculate the moisture content, based on wet mass (weight), to the nearest 0.1 percent as follows:

$$\text{Percent Moisture} = \frac{\text{Wt. as received - Wt. SSD}}{\text{Wt. as received}} \times 100$$

A negative result is due to absorption of the aggregate rather than free moisture.

2. The percent of moisture, based on saturated-surface-dry mass (weight), is calculated to the nearest 0.1 percent as follows:

$$\text{Percent Moisture SSD} = \frac{\text{\% Moisture as received}}{\text{100 - \% Moisture by wet mass (weight) as received}} \times 100$$

or

$$\text{Percent Moisture (SSD)} = \frac{\text{wet mass (weight) - saturated - surface - dry mass (weight)}}{\text{saturated - surface - dry mass (weight)}} \times 100$$

PROCEDURE C - WATER ABSORPTION IN AGGREGATE

This procedure is used for determining absorption of aggregates for use in asphaltic concrete as well as determining specification compliance for absorption.

A. Apparatus

1. Balance having the capacity of at least 5000 grams and accurate to 0.5 gram

2. Oven or hot plate

B. Preparation of Sample

1. Obtain a test sample of at least 1000 grams of fine aggregate and 2000 grams of coarse aggregate by following the appropriate procedure outlined in IM 307.
2. When the sample is not in a saturated condition it must be immersed in water at room temperature for a minimum of 15 hours before continuing with the test.
3. Allow the saturated sample to attain a surface-dry condition by following the procedure in IM 307.

C. Test Procedure

1. Weigh the saturated, surface-dry sample to the nearest 0.5 gram.
2. Dry the sample in the oven or on the hot plate or stove to a constant weight (mass).
3. Allow the sample to cool and weigh to the nearest 0.5 gram.

D. Calculation

1. The percent absorption, based on the oven dry mass (weight) is calculated to the nearest 0.01 percent as follows:

   Percent Absorption =

$$\frac{\text{Saturated - surface - dry mass (weight) - oven dry mass (weight)}}{\text{oven dry mass (weight)}} \times 100$$

METHOD OF MAKING, PROTECTING, CURING & TESTING CONCRETE CYLINDERS

SCOPE

This method covers procedures for making, protecting, and curing, according to AASHTO) T23. This method also covers testing concrete cylinder specimens for compressive strength. This test procedure is a supplement and not a replacement for the beam test to determine when a structure may be put in service.

HEADER

I. MAKING, PROTECTING & CURING SPECIMENS

A. Apparatus for Making Specimens

1. 6 in. x 12 in. (152.4 mm x 304.8 mm) or 4 in. x 8 in. (101.6 mm x 203.2 mm) steel, brass, or single-use plastic vertical molds meeting the requirements of AASHTO M205.

2. Molds shall be either of the vertical or horizontal type.

3. Tamping rods shall comply with AASHTO T23.

4. Internal or external vibrators may be used. They shall comply with AASHTO T23 with the exception that the diameter of the vibrating element of the internal vibrator shall vary for each specimen size, as stated below. External vibrators shall be either a table type or a plank type.

5. Rubber hammer or equivalent

6. Wood float or equivalent

B. Making Test Specimens

1. The concrete shall be sampled in accordance with IM 327, Sampling Freshly Mixed Concrete.

2. Before casting specimens, the inside surfaces of the steel or brass molds should be clean and treated with a thin coating of light grease or form oil.

3. Consolidation may be rodding with a tamping rod, or by vibration, either internal or external. Concrete with slump greater than 3 inches (75 mm) shall be consolidated by rodding. Concrete with slump of 1 inch to 3 inches (25 mm to 75 mm) shall be consolidated by rodding or vibration. Concrete with slump of less than1 inch (25 mm) shall be consolidated by vibration.

a. Rodding. 4 in. x 8 in. (101.6 mm x 203.2 mm) vertical specimens shall receive 25 roddings evenly distributed over two equal layers and 6 in x 12 in. (152.4 mm x 304.8 mm) vertical specimens shall receive 25 roddings evenly distributed over three equal layers. The bottom layer shall be rodded throughout its depth. For each upper layer, the rod shall penetrate 1/2 inch (13 mm) into the underlying layer. After rodding each layer, the sides and ends of the mold shall be tapped with a rubber hammer until the surface of the concrete is relatively smooth. Use an open hand to tap the single-use molds. After consolidation, strike off the horizontal surface and finish with a float or trowel.

b. Internal Vibration. The diameter of the vibrating element shall be 3/4 inch to 1 inch (19 mm to 25 mm) for the 4 in. x 8 in. (101.6 mm x 203.2 mm) specimens. The diameter of the vibrating element shall be 3/4 inch to 1 1/2 inch (19 mm to 38 mm) for 6 in. x 12 in. (152.4 mm x 304.8 mm) specimens. The molds shall be filled in two equal layers. Each layer shall be vibrated only long enough to make the surface relatively smooth. The time required will vary with the consistency of the concrete. Over vibration may cause segregation. In compacting the concrete, the vibrator shall not rest on or touch the sides of the mold. When vibrating the top layer, the element shall penetrate about 1/2 inch (13 mm) into the bottom layer. After vibrating, tap the sides of the mold with a rubber hammer to ensure removal of entrapped air bubbles at the surface of the mold. Use an open hand to tap the single-use molds. When consolidation is complete, strike off and finish with a wood float or trowel.

c. External Vibration. Each layer shall be vibrated only until the surface is relatively smooth. Take care to ensure that the mold is rigidly attached or securely held against the vibrating table or vibrating surface. After consolidation, strike off and finish with a trowel or float.

C. Protecting & Curing

1. Initial Curing. During the first 24 hours after molding, specimens shall be stored under conditions that maintain the temperature immediately adjacent to the specimens in the range of 50°F to 80°F (10°C to 27°C) and prevent loss of moisture from the specimens. This may be done by covering specimens with wet burlap and placing a plastic sheet over the burlap, or use other suitable methods to ensure that the foregoing requirements are met.

2. Curing to Determine Form Removal Time or When a Structure May be Put in Service. Cure test specimens as nearly as practicable in the same manner as the concrete in the structure. After 48 ± 4 hours, remove specimens from the molds. They shall be stored as near as possible to the point in the structure they represent and shall be afforded the same temperature protection and moisture environment as the structure until the time of testing. Specimens shall be tested while in the moisture condition resulting from the curing they receive.

3. Curing To Check the Adequacy of Laboratory Mix Proportions for Strength or As a Basis For Acceptance or For Quality Control. For this purpose, specimens are to be removed from the molds at the end of 16 to 24 hours and stored in a moist condition at 68°F to 81.5°F (20°C to 27.5°C) until the time of test. This condition can be met by immersion in saturated limewater. **NOTE:** Lime-saturated water is prepared by mixing 1 oz. (28 g) of hydrated lime, meeting the requirements of ASTM C977, with 1 gallon (3.8 liters) of water.

4. Steam Curing. When artificial heat is used to accelerate curing, concrete specimens shall be placed with the unit being cured and shall receive the same curing as the concrete they represent. Prior to testing the specimens, the temperature of the concrete shall be lowered to the temperature of the surrounding air at a rate not to exceed 40°F (22°C).

5. Special care must be given to ensure that specimens are not damaged during handling. For 16 to 24 hours after molding, specimens shall not be moved.

II. TESTING CONCRETE SPECIMENS FOR COMPRESSION

A. Apparatus

1. The testing machine shall conform to AASHTO T22. Manually operated testing machines will be accepted.

B. Time of Testing

1. Make compression tests of moist cured specimens as soon as practicable after removal from curing. Keep specimens moist by use of wet burlap or other suitable covering, which will ensure similar protection until actual time of testing.

2. The time to test specimens otherwise cured will be as directed by the engineer.

C. Test Specimens

1. Neither end of compressive test specimens when tested shall depart from the perpendicularity to the axis by more than 0.5 degrees [approximately 1/8 in. in 12 in. (3 mm in 300 mm)]

2. The ends of the specimens that are not plane within 0.002 in. (0.05 mm) shall be capped. The planeness of the ends of every tenth specimen should be checked by means of a straightedge and feeler gauge, making a minimum of three measurements on different diameters, to insure that the end surfaces do not depart from a plane by more than 0.002 in. (0.05 mm).

3. The top surface of vertically cast specimens shall be capped.

D. Capping

1. Capping equipment and procedures shall comply with that described in AASHTO T231.

2. Hardened specimens, which have been moist-cured, may be capped with a neat Portland Cement paste or sulfur mortar meeting the requirements set forth below:

    a. The Portland Cement in neat Portland Cement caps shall conform to AASHTO M85, Type I or Type III.

    b. Sulfur mortar shall conform to the compositional and compressive strength requirements of ASTM C287 for sulfur mortar, and shall be capable of developing a strength of at least 4000 psi (27.6 MPa) in two hours when tested as 2-inch (50-mm) cubes.

3. Specimens, which are to be tested in an air-dry condition, should, be capped with sulfur mortar.

4. If it is found necessary to cap specimens, and equipment and facilities for capping are not available, arrangements should be made to test such specimens at the Central Laboratory or other qualified laboratory.

E. Test Procedure

1. Placing Specimen

    a. Place the plain (lower) bearing block with its hardened face up, on the table or platen of the testing machine directly under the spherically seated (upper) bearing block.

    b. Wipe clean the bearing faces of the upper and lower bearing blocks and of the test specimen.

    c. Carefully align the axis of the specimen with the center thrust of the spherically seated block.

    d. As the spherically seated block is brought to bear on the specimen, rotate its moveable portion gently by hand so that uniform seating is obtained.

2. Rate of Loading

    a. Apply the load continuously and without shock. Apply the load at a constant rate within the range of 20 to 50 psi (138 kPa to 345 kPa) per second. During the application of the first half of the estimated maximum load, a higher rate of loading may be permitted.

    b. Do not make any adjustment in the controls of the testing machine while the specimen is yielding, especially in the period just before failure.

c. Increase the load until the specimen yields or fails, and record the maximum load carried by the specimen during test.

d. Note the type of failure (Figure 1) and the appearance of the concrete if the break appears to be abnormal.

F. Calculations

1. Calculate the compressive strength of the specimen by dividing the maximum load carried by the specimen during the test by the cross sectional area, and express the result to the nearest 10 psi (0.1 MPa). The attached tables may be used to facilitate these computations.

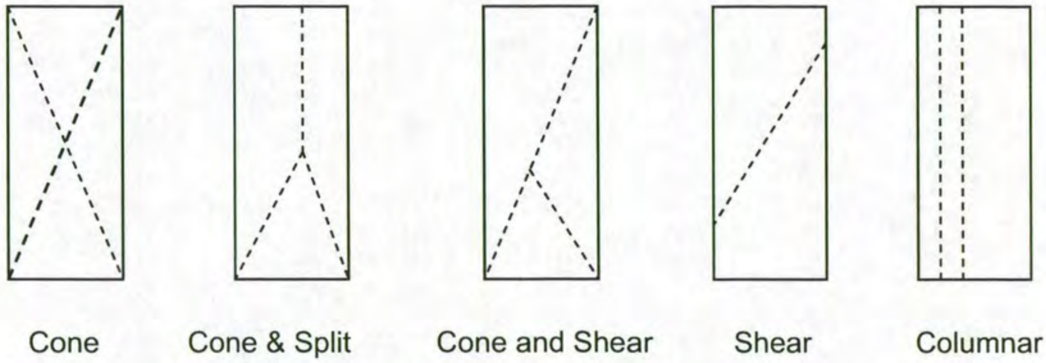


Figure 1. Compressive Fracture Types

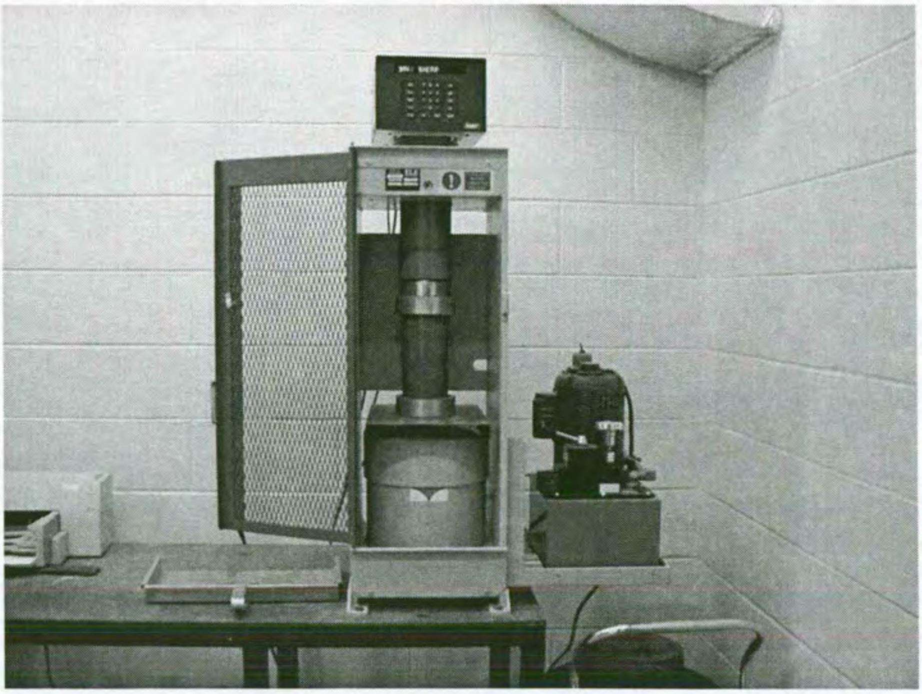


Figure 2. Compression Testing Machine

Table for Computing MPa/1000 kPa on 6 in. to 12 in. (154.mm x 304.8 mm) Cylinders
Area = 0.01824m²

Load (kN)	MPa	Load (kN)	MPa	Load (kN)	MPa	Load (kN)	MPa	Load (kN)	MPa
175	9.59	425	23.30	675	37.01	925	50.71	1175	64.42
180	9.87	430	23.57	680	37.28	930	50.99	1180	64.69
185	10.14	435	23.85	685	37.55	935	51.26	1185	64.97
190	10.42	440	24.12	690	37.83	940	51.54	1190	65.24
195	10.69	445	24.40	695	38.10	945	51.81	1195	65.52
200	10.96	450	24.67	700	38.38	950	52.08	1200	65.79
205	11.24	455	24.95	705	38.65	955	52.36		
210	11.51	460	25.22	710	38.93	960	52.63		
215	11.79	465	25.49	715	39.20	965	52.91		
220	12.06	470	25.77	720	39.47	970	53.18		
225	12.34	475	26.04	725	39.75	975	53.45		
230	12.61	480	26.32	730	40.02	980	53.73		
235	12.88	485	26.59	735	40.30	985	54.00		
240	13.16	490	26.86	740	40.57	990	54.28		
245	13.43	495	27.14	745	40.84	995	54.55		
250	13.71	500	27.41	750	41.12	1000	54.82		
255	13.98	505	27.69	755	41.39	1005	55.10		
260	14.25	510	27.96	760	41.67	1010	55.37		
265	14.53	515	28.23	765	41.94	1015	55.65		
270	14.80	520	28.51	770	42.21	1020	55.92		
275	15.06	525	28.78	775	42.49	1025	56.20		
280	15.35	530	29.06	780	42.76	1030	56.47		
285	15.63	535	29.33	785	43.04	1035	56.74		
290	15.90	540	29.61	790	43.31	1040	57.02		
295	16.17	545	29.88	795	43.59	1045	57.29		
300	16.45	550	30.15	800	43.86	1050	57.57		
305	16.72	555	30.43	805	44.13	1055	57.84		
310	17.00	560	30.70	810	44.41	1060	58.11		
315	17.27	565	30.98	815	44.68	1065	58.39		
320	17.54	570	31.25	820	44.96	1070	58.66		
325	17.82	575	31.52	825	45.23	1075	58.94		
330	18.09	580	31.80	830	45.50	1080	59.21		
335	18.37	585	32.07	835	45.78	1085	59.48		
340	18.64	590	32.35	840	46.05	1090	59.76		
345	18.91	595	32.62	845	46.33	1095	60.03		
350	19.19	600	32.89	850	46.60	1100	60.31		
355	19.46	605	33.17	855	46.88	1105	60.58		
360	19.74	610	33.44	860	47.15	1110	60.86		
365	20.01	615	33.72	865	47.42	1115	61.13		
370	20.29	620	33.99	870	47.70	1120	61.40		
375	20.56	625	34.27	875	47.97	1125	61.68		
380	20.83	630	34.54	880	48.25	1130	61.95		
385	21.11	635	34.81	885	48.52	1135	62.23		
390	21.38	640	35.09	890	48.79	1140	62.50		
395	21.66	645	35.36	895	49.07	1145	62.77		
400	21.93	650	35.64	900	49.34	1150	63.05		
405	22.20	655	35.91	905	49.62	1155	63.32		
410	22.48	660	36.18	910	49.89	1160	63.60		
415	22.75	665	36.46	915	50.16	1165	63.87		
420	23.03	670	36.73	920	50.44	1170	64.14		

(Load in Thousands)

Table for Computing lb./in.² on 6 in. x 12 in. Cylinders
Area = 28.2744 in.²

Load	Psi	Load	Psi	Load	Psi	Load	Psi	Load	Psi
40	1410	90	3180	140	4950	190	6720	240	8490
41	1450	91	3220	141	4990	191	6760	241	8520
42	1490	92	3250	142	5020	192	6790	242	8560
43	1520	93	3290	143	5060	193	6830	243	8590
44	1560	94	3320	144	5090	194	6860	244	8630
45	1590	95	3360	145	5130	195	6900	245	8670
46	1630	96	3400	146	5160	196	6930	246	8700
47	1660	97	3430	147	5200	197	6970	247	8740
48	1700	98	3470	148	5230	198	7000	248	8770
49	1730	99	3500	149	5270	199	7040	249	8810
50	1770	100	3540	150	5310	200	7070	250	8840
51	1800	101	3570	151	5340	201	7110	251	8880
52	1840	102	3610	152	5380	202	7140	252	8910
53	1870	103	3640	153	5410	203	7180	253	8950
54	1910	104	3680	154	5450	204	7220	254	8980
55	1950	105	3710	155	5480	205	7250	255	9020
56	1980	106	3750	156	5520	206	7290	256	9050
57	2020	107	3780	157	5550	207	7320	257	9090
58	2050	108	3820	158	5590	208	7360	258	9120
59	2090	109	3860	159	5620	209	7390	259	9160
60	2120	110	3890	160	5660	210	7430	260	9200
61	2160	111	3930	161	5690	211	7460	261	9230
62	2190	112	3960	162	5730	212	7500	262	9270
63	2230	113	4000	163	5760	213	7530	263	9300
64	2260	114	4030	164	5800	214	7570	264	9340
65	2300	115	4070	165	5840	215	7600	265	9370
66	2330	116	4100	166	5870	216	7640	266	9410
67	2370	117	4140	167	5910	217	7670	267	9440
68	2410	118	4170	168	5940	218	7710	268	9480
69	2440	119	4210	169	5980	219	7750	269	9510
70	2480	120	4240	170	6010	220	7780		
71	2510	121	4280	171	6050	221	7820		
72	2550	122	4310	172	6080	222	7850		
73	2580	123	4350	173	6120	223	7890		
74	2620	124	4390	174	6150	224	7920		
75	2650	125	4420	175	6190	225	7960		
76	2690	126	4460	176	6220	226	7990		
77	2720	127	4490	177	6260	227	8030		
78	2760	128	4530	178	6300	228	8060		
79	2790	129	4560	179	6330	229	8100		
80	2830	130	4600	180	6370	230	8130		
81	2860	131	4630	181	6400	231	8170		
82	2900	132	4670	182	6440	232	8210		
83	2940	133	4700	183	6470	233	8240		
84	2970	134	4740	184	6510	234	8280		
85	3010	135	4770	185	6540	235	8310		
86	3040	136	4810	186	6580	236	8350		
87	3080	137	4850	187	6610	237	8380		
88	3110	138	4880	188	6650	238	8420		
89	3150	139	4920	189	6680	239	8450		

(Load in Thousands)

Table for Computing lb./in.^{2} on 4 in. x 8 in. Cylinders
Area = 12.5666 in.^{2}

Load	Psi	Load	Psi	Load	Psi	Load	Psi
10	800	50	3980	90	7160	130	10350
11	880	51	4060	91	7240	131	10420
12	950	52	4140	92	7320	132	10500
13	1030	53	4220	93	7400	133	10580
14	1110	54	4300	94	7480	134	10660
15	1190	55	4380	95	7560	135	10740
16	1270	56	4460	96	7640	136	10820
17	1350	57	4540	97	7720	137	10900
18	1430	58	4620	98	7800	138	10980
19	1510	59	4700	99	7880	139	11060
20	1590	60	4770	100	7960	140	11140
21	1670	61	4850	101	8040	141	11220
22	1750	62	4930	102	8120	142	11300
23	1830	63	5010	103	8200	143	11380
24	1910	64	5090	104	8280	144	11460
25	1990	65	5170	105	8360	145	11540
26	2070	66	5250	106	8440	146	11620
27	2150	67	5330	107	8520	147	11700
28	2230	68	5410	108	8590	148	11780
29	2310	69	5490	109	8670	149	11860
30	2390	70	5570	110	8750	150	11940
31	2470	71	5650	111	8830	151	12020
32	2550	72	5730	112	8910	152	12100
33	2630	73	5810	113	8990	153	12180
34	2710	74	5890	114	9070	154	12260
35	2790	75	5970	115	9150	155	12330
36	2860	76	6050	116	9230	156	12410
37	2940	77	6130	117	9310	157	12490
38	3020	78	6210	118	9390	158	12570
39	3100	79	6290	119	9470	159	12650
40	3180	80	6370	120	9550	160	12730
41	3260	81	6450	121	9630	161	12810
42	3340	82	6530	122	9710	162	12890
43	3420	83	6610	123	9790	163	12970
44	3500	84	6680	124	9870	164	13050
45	3580	85	6760	125	9950	165	13130
46	3660	86	6840	126	10030	166	13210
47	3740	87	6920	127	10110	167	13290
48	3820	88	7000	128	10190	168	13370
49	3900	89	7080	129	10270	169	13450

Table for Computing MPa on 4 in. x 8 in. (101.6 mm x 203.3 mm) Cylinders
Area = 0.008107 m²

Load (kN)	MPa	Load (kN)	MPa	Load (kN)	MPa	Load (kN)	MPa
45	5.55	245	30.22	445	54.89	645	79.56
50	6.17	250	30.84	450	55.51	650	80.18
55	6.78	255	31.45	455	56.12	655	80.79
60	7.40	260	32.07	460	56.74	660	81.41
65	8.02	265	32.69	465	57.36	665	82.03
70	8.63	270	33.30	470	57.97	670	82.64
75	9.25	275	33.92	475	58.59	675	83.26
80	9.87	280	34.54	480	59.21	680	83.88
85	10.48	285	35.15	485	59.82	685	84.49
90	11.10	290	35.77	490	60.44	690	85.11
95	11.72	295	36.39	495	61.06	695	85.73
100	12.34	300	37.01	500	61.68	700	86.35
105	12.95	305	37.62	505	62.29	705	86.96
110	13.57	310	38.24	510	62.91	710	87.58
115	14.19	315	38.86	515	63.53	715	88.20
120	14.80	320	39.47	520	64.14	720	88.81
125	15.42	325	40.09	525	64.76	725	89.43
130	16.04	330	40.71	530	65.38	730	90.05
135	16.65	335	41.32	535	65.99	735	90.66
140	17.27	340	41.94	540	66.61	740	91.28
145	17.89	345	42.56	545	67.23	745	91.90
150	18.50	350	43.17	550	67.84	750	92.51
155	19.12	355	43.79	555	68.46	755	93.13
160	19.74	360	44.41	560	69.08	760	93.75
165	20.35	365	45.02	565	69.69		
170	20.97	370	45.64	570	70.31		
175	21.59	375	46.26	575	70.93		
180	22.20	380	46.87	580	71.54		
185	22.82	385	47.49	585	72.16		
190	23.44	390	48.11	590	72.78		
195	24.05	395	48.72	595	73.39		
200	24.67	400	49.34	600	74.01		
205	25.29	405	49.96	605	74.63		
210	25.90	410	50.57	610	75.24		
215	26.52	415	51.19	615	75.86		
220	27.14	420	51.81	620	76.48		
225	27.75	425	52.42	625	77.09		
230	28.37	430	53.04	630	77.71		
235	28.99	435	53.66	635	78.33		
240	29.60	440	54.27	640	78.94		

October 17, 2006
Supersedes October 19, 2004

Matls. IM 316

FLEXURAL STRENGTH OF CONCRETE

SCOPE

This test method is used for determining the flexural strength of concrete by the use of a simple beam with center-point loading.

PROCEDURE

A. Apparatus

1. Hydraulic testing machines provided on Portland Cement Concrete paving projects shall conform to AASHTO T-177. The hydraulic machine consists of a frame to hold the specimen, a hand-operated hydraulic jack, and a pressure gauge to read the load. Practically all of the hydraulic machines have a micro pump in the loading line to facilitate control of the last half of the load within specifications, and without pause in loading. A calibration sheet is included with each machine of this type. Additional equipment needed includes a caliper, plastic ruler and a tri-square. The hydraulic test machine needs to be calibrated annually by the DOT Central Laboratory. Calibration sheets with each machine will indicate the date last calibrated.

B. Test Specimen

1. The test specimen shall have approximate dimensions of 6 in. x 6 in. x 20 in. (152 mm x 152 mm x 508 mm). The test specimen shall be kept wet until the time of the test.

C. Test Procedure

1. Either before or after the beam is placed in the testing machine, draw a reference line on the top and bottom of the beam, as cast, about 10 in. (250 mm) from the end of the specimen. The two reference lines should be exactly opposite each other. A line drawn across the bottom of the beam, as placed in the machine, will meet these two lines, and will be perpendicular to them. The bottom of the beam as placed in the machine will be the side of the beam as cast.
2. Insert the stirrup pins in the slots at the bottom of the stirrups to prevent the stirrups from swinging while the beam is being placed in the machine. This also assures that the support bearings are in the correct position.
3. Place the beam in the testing machine so that the two reference lines on the side of the beam are directly under the centerline of the center bearing. The maximum fiber stress during application of the load will occur in the outer fiber in the line drawn across the bottom of the beam, this line being directly under the load.
4. Rotate the micro pump handle counter-clockwise to expose the maximum number of threads, and close the loading valve on the pump.

5. Apply a small initial load, and remove the stirrup pins.

6. The load may be applied rapidly up to approximately 50 percent of the estimated breaking load with the pump handle. The final half of the loading is accomplished by turning the crank of the micro pump, at a rate that the extreme fiber stress does not exceed 150 psi (1.0 MPa) per minute. This is approximately 1200 pounds (500 kg) per minute on the test gauge.

7. Make measurements to the nearest 0.02 in. (0.5 mm) to determine the average width and average depth of the specimen at the section of failure.

8. Measure the distance from the line drawn at the center of the span to the location of the break on the bottom side of the beam as tested. If this distance exceeds 1 1/2 in. (40 mm), the test results will not be used in determining when a pavement can be opened to traffic, when forms may be removed from a structure, or when a concrete structure can be subjected to exterior loads, which produce flexure.

D. Calculations

1. From the calibration sheet furnished with each machine, determine the corrected load placed upon the beam. The machine should be calibrated annually.

2. Calculate the modulus of rupture as follows:

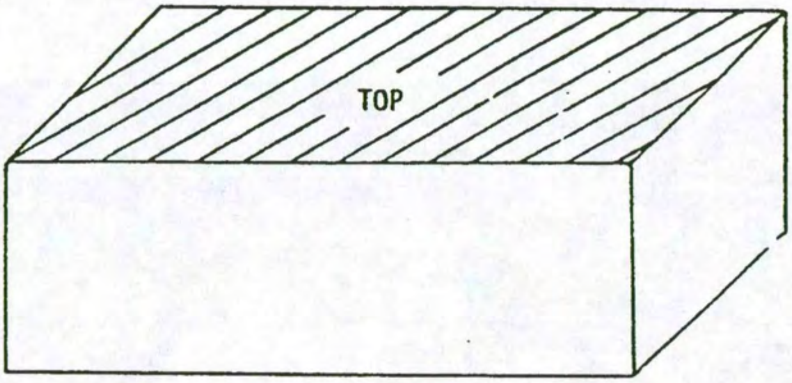
$$R = \frac{3Pl}{2bd^2}$$

<u>Where:</u>

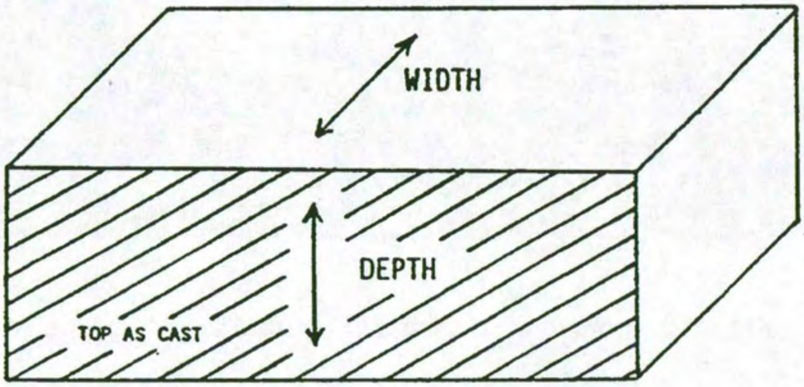
R = Modulus of rupture, MPa or psi.
P = Corrected load indicated, N or lb.
l = Span length, mm or in., between supports (or 18 in. or 457 mm)
b = Width of beam at point of fracture, mm or in.
d = Depth of beam at point of fracture, mm or in.

3. The typical range of modulus of rupture should be from 300 psi to 700 psi (2 MPa to 5 MPa). Report the modulus of rupture to the nearest 5 psi (0.05 MPa).

E. The following figure shows the beam as cast, and the beam as placed in the flexural testing machine.



As Cast



As Placed in the Machine

Figure 1

F. Precautions

Always make sure the pointers on the gauge are set at zero before any loading begins.

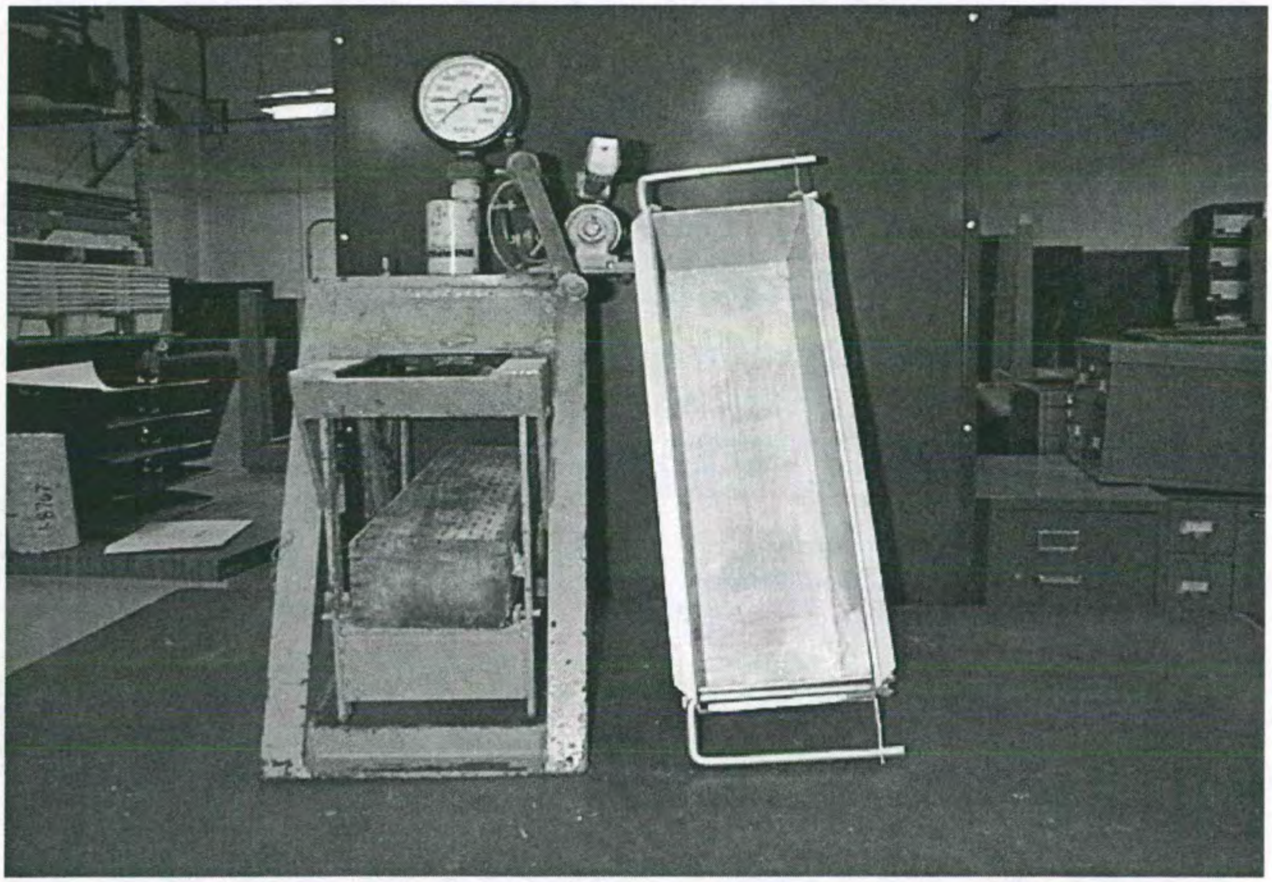


Figure 2. Concrete Specimen in Hydraulic Testing Machine

Concrete Beam Coefficients
US Units

Width (in.)

Depth (in.)	5.82	5.84	5.86	5.88	5.9	5.92	5.94	5.96	5.98
5.8	0.137907	0.137434	0.136965	0.136499	0.136037	0.135577	0.135121	0.134667	0.134217
5.82	0.136960	0.136491	0.136025	0.135563	0.135103	0.134647	0.134193	0.133743	0.133296
5.84	0.136024	0.135558	0.135095	0.134636	0.134179	0.133726	0.133276	0.132829	0.132384
5.86	0.135097	0.134634	0.134175	0.133718	0.133265	0.132815	0.132368	0.131924	0.131482
5.88	0.134179	0.133720	0.133264	0.132810	0.132360	0.131913	0.131469	0.131028	0.130589
5.9	0.133271	0.132815	0.132362	0.131911	0.131464	0.131020	0.130579	0.130141	0.129706
5.92	0.132372	0.131919	0.131469	0.131022	0.130577	0.130136	0.129698	0.129263	0.128831
5.94	0.131482	0.131032	0.130585	0.130141	0.129700	0.129261	0.128826	0.128394	0.127965
5.96	0.130602	0.130154	0.129710	0.129269	0.128831	0.128395	0.127963	0.127534	0.127107
5.98	0.129729	0.129285	0.128844	0.128406	0.127970	0.127538	0.127109	0.126682	0.126258
6	0.128866	0.128425	0.127986	0.127551	0.127119	0.126689	0.126263	0.125839	0.125418
6.02	0.128011	0.127573	0.127137	0.126705	0.126275	0.125849	0.125425	0.125004	0.124586
6.04	0.127165	0.126729	0.126297	0.125867	0.125441	0.125017	0.124596	0.124178	0.123762
6.06	0.126327	0.125894	0.125465	0.125038	0.124614	0.124193	0.123775	0.123359	0.122947
6.08	0.125497	0.125067	0.124640	0.124216	0.123795	0.123377	0.122962	0.122549	0.122139
6.1	0.124675	0.124249	0.123824	0.123403	0.122985	0.122569	0.122157	0.121747	0.121340
6.12	0.123862	0.123438	0.123016	0.122598	0.122182	0.121770	0.121360	0.120952	0.120548
6.14	0.123056	0.122635	0.122216	0.121801	0.121388	0.120978	0.120570	0.120166	0.119764
6.16	0.122259	0.121840	0.121424	0.121011	0.120601	0.120193	0.119789	0.119387	0.118987
6.18	0.121469	0.121053	0.120639	0.120229	0.199822	0.119417	0.119015	0.118615	0.118219

Modulus of Rupture = Total Load X Coefficient
R (in psi) = P (in lbs.) X Coefficient (in in-2)

Concrete Beam Coefficients
US Units

Width (in.)

	6	6.02	6.04	6.06	6.08	6.1	6.12	6.14	6.16
Depth (in.)									
5.8	0.133769	0.133325	0.132883	0.132445	0.132009	0.131576	0.131146	0.130719	0.130295
5.82	0.132852	0.132410	0.131972	0.131536	0.131103	0.130674	0.130247	0.129822	0.129401
5.84	0.131943	0.131505	0.131069	0.130637	0.130207	0.129780	0.129356	0.128935	0.128516
5.86	0.131044	0.130609	0.130176	0.129747	0.129320	0.128896	0.128475	0.128056	0.127640
5.88	0.130154	0.129722	0.129292	0.128865	0.128442	0.128020	0.127602	0.127186	0.126773
5.9	0.129273	0.128844	0.128417	0.127993	0.127572	0.127154	0.126738	0.126326	0.125915
5.92	0.128401	0.127975	0.127551	0.127130	0.126712	0.126296	0.125884	0.125473	0.125066
5.94	0.127538	0.127114	0.126693	0.126275	0.125860	0.125447	0.125037	0.124630	0.124225
5.96	0.126683	0.126263	0.125845	0.125429	0.125017	0.124607	0.124199	0.123795	0.123393
5.98	0.125838	0.125419	0.125004	0.124592	0.124182	0.123775	0.123370	0.122968	0.122569
6	0.125000	0.124585	0.124172	0.123762	0.123355	0.122951	0.122549	0.122150	0.121753
6.02	0.124171	0.123758	0.123348	0.122941	0.122537	0.122135	0.121736	0.121340	0.120946
6.04	0.123350	0.122940	0.122533	0.122129	0.121727	0.121328	0.120931	0.120537	0.120146
6.06	0.122537	0.122130	0.121726	0.121324	0.120925	0.120528	0.120134	0.119743	0.119354
6.08	0.121732	0.121328	0.120926	0.120527	0.120130	0.119737	0.119345	0.118957	0.118570
6.1	0.120935	0.120533	0.120134	0.119738	0.119344	0.118953	0.118564	0.118178	0.117794
6.12	0.120146	0.119747	0.119350	0.118957	0.118565	0.118176	0.117790	0.117407	0.117025
6.14	0.119365	0.118968	0.118574	0.118183	0.117794	0.117408	0.117024	0.116643	0.116264
6.16	0.118591	0.118197	0.117805	0.117417	0.117030	0.116647	0.116266	0.115887	0.115511
6.18	0.117824	0.117433	0.117044	0.116658	0.116274	0.115893	0.115514	0.115138	0.114764

Modulus of Rupture = Total Load X Coefficient
R (in psi) = P (in lbs) X Coefficient (in in-2)

Concrete Beam Coefficients
Metric Units

Width (mm)

Depth (mm)	147.5	148	148.5	149	149.5	150	150.5	151	151.5	152
147	0.000215	0.000214	0.000214	0.000213	0.000212	0.000211	0.000211	0.000210	0.000209	0.000209
147.5	0.000214	0.000213	0.000212	0.000211	0.000211	0.000210	0.000209	0.000209	0.000208	0.000207
148	0.000212	0.000211	0.000211	0.000210	0.000209	0.000209	0.000208	0.000207	0.000207	0.000206
148.5	0.000211	0.000210	0.000209	0.000209	0.000208	0.000207	0.000207	0.000206	0.000205	0.000205
149	0.000209	0.000209	0.000208	0.000207	0.000207	0.000206	0.000205	0.000204	0.000204	0.000203
149.5	0.000208	0.000207	0.000207	0.000206	0.000205	0.000204	0.000204	0.000203	0.000202	0.000202
150	0.000207	0.000206	0.000205	0.000204	0.000204	0.000203	0.000202	0.000202	0.000201	0.000200
150.5	0.000205	0.000204	0.000204	0.000203	0.000202	0.000202	0.000201	0.000200	0.000200	0.000199
151	0.000204	0.000203	0.000202	0.000202	0.000201	0.000200	0.000200	0.000199	0.000198	0.000198
151.5	0.000202	0.000202	0.000201	0.000200	0.000200	0.000199	0.000198	0.000198	0.000197	0.000196
152	0.000201	0.000200	0.000200	0.000199	0.000198	0.000198	0.000197	0.000196	0.000196	0.000195
152.5	0.000200	0.000199	0.000198	0.000198	0.000197	0.000197	0.000196	0.000195	0.000195	0.000194
153	0.000199	0.000198	0.000197	0.000197	0.000196	0.000195	0.000195	0.000194	0.000193	0.000193
153.5	0.000197	0.000197	0.000196	0.000195	0.000195	0.000194	0.000193	0.000193	0.000192	0.000191
154	0.000196	0.000195	0.000195	0.000194	0.000193	0.000193	0.000192	0.000191	0.000191	0.000190
154.5	0.000195	0.000194	0.000193	0.000193	0.000192	0.000191	0.000191	0.000190	0.000190	0.000189
155	0.000193	0.000193	0.000192	0.000191	0.000191	0.000190	0.000190	0.000189	0.000188	0.000188
155.5	0.000192	0.000192	0.000191	0.000190	0.000190	0.000189	0.000188	0.000188	0.000187	0.000187
156	0.000191	0.000190	0.000190	0.000189	0.000188	0.000188	0.000187	0.000187	0.000186	0.000185
156.5	0.000190	0.000189	0.000188	0.000188	0.000187	0.000187	0.000186	0.000185	0.000185	0.000184
157	0.000189	0.000188	0.000187	0.000187	0.000186	0.000185	0.000185	0.000184	0.000184	0.000183

Modulus of Rupture = Total Load X Coefficient
R (in MPa) = P (in N) X Coefficient (in mm-2)

Concrete Beam Coefficients
Metric Units

	Width (mm)									
Depth (mm)	152.5	153	153.5	154	154.5	155	155.5	156	156.5	157
147	0.000208	0.000207	0.000207	0.000206	0.000205	0.000205	0.000204	0.000203	0.000203	0.000202
147.5	0.000207	0.000206	0.000205	0.000205	0.000204	0.000203	0.000203	0.000202	0.000201	0.000201
148	0.000205	0.000205	0.000204	0.000203	0.000203	0.000202	0.000201	0.000201	0.000200	0.000199
148.5	0.000204	0.000203	0.000203	0.000202	0.000201	0.000201	0.000200	0.000199	0.000199	0.000198
149	0.000202	0.000202	0.000201	0.000200	0.000200	0.000199	0.000199	0.000198	0.000197	0.000197
149.5	0.000201	0.000200	0.000200	0.000199	0.000199	0.000198	0.000197	0.000197	0.000196	0.000195
150	0.000200	0.000199	0.000198	0.000198	0.000197	0.000197	0.000196	0.000195	0.000195	0.000194
150.5	0.000198	0.000198	0.000197	0.000197	0.000196	0.000195	0.000195	0.000194	0.000193	0.000193
151	0.000197	0.000196	0.000196	0.000195	0.000195	0.000194	0.000193	0.000193	0.000192	0.000191
151.5	0.000196	0.000195	0.000195	0.000194	0.000193	0.000193	0.000192	0.000191	0.000191	0.000190
152	0.000195	0.000194	0.000193	0.000193	0.000192	0.000191	0.000191	0.000190	0.000190	0.000189
152.5	0.000193	0.000193	0.000192	0.000191	0.000191	0.000190	0.000190	0.000189	0.000188	0.000188
153	0.000192	0.000191	0.000191	0.000190	0.000190	0.000189	0.000188	0.000188	0.000187	0.000187
153.5	0.000191	0.000190	0.000190	0.000189	0.000188	0.000188	0.000187	0.000186	0.000186	0.000185
154	0.000190	0.000189	0.000188	0.000188	0.000187	0.000186	0.000186	0.000185	0.000185	0.000184
154.5	0.000188	0.000188	0.000187	0.000186	0.000186	0.000185	0.000185	0.000184	0.000184	0.000183
155	0.000187	0.000186	0.000186	0.000185	0.000185	0.000184	0.000183	0.000183	0.000182	0.000182
155.5	0.000186	0.000185	0.000185	0.000184	0.000183	0.000183	0.000182	0.000182	0.000181	0.000181
156	0.000185	0.000184	0.000184	0.000183	0.000182	0.000182	0.000181	0.000181	0.000180	0.000179
156.5	0.000184	0.000183	0.000182	0.000182	0.000181	0.000181	0.000180	0.000179	0.000179	0.000178
157	0.000182	0.000182	0.000181	0.000181	0.000180	0.000179	0.000179	0.000178	0.000178	0.000177

Modulus of Rupture = Total Load X Coefficient
R (in MPa) = P (in N) X Coefficient (in mm-2)

October 19, 2004
Supersedes April 15, 2003

Matls. IM 317

SLUMP OF HYDRAULIC CEMENT CONCRETE

SCOPE

This procedure provides instructions for determining the slump of hydraulic cement concrete. It is not applicable to non-plastic or non-cohesive concrete, nor when the maximum size of the coarse aggregate is over 2 in. (50 mm).

SIGNIFICANCE

The slump test is used to determine the consistency of concrete. Consistency is a measure of the relative fluidity or mobility of the mixture. Slump does not measure the water content or workability of the concrete. While it is true that an increase or decrease in the water content will cause a corresponding increase or decrease in the slump of the concrete, many other factors can cause slump to change without any change to water content. One cannot assume that the water/cement ratio is being maintained simply because the slump is within specification limits.

PROCEDURE

A. Apparatus

1. Slump Cone. The slump cone shall conform to AASHTO T 119: The mold shall be provided with foot pieces and handles. The mold may be constructed either with or without a seam. The interior of the mold shall be relatively smooth and free from projections such as protruding rivets. The mold shall be free of dents. A mold that clamps to a rigid non-absorbent base plate is acceptable provided the clamping arrangement is such that it can be fully released without movement of the mold.

2. Tamping Rod. The tamping rod shall be 5/8 in. (16 mm) in diameter and approximately 24 in. (600 mm) in length, having a hemispherical tip.

3. Scoop.

4. Tape Measure or Ruler. These should have at least 1/8 in. (5 mm) gradations.

5. Base. The base shall be rigid with a non-absorbent surface on which to set the slump cone.

B. Test Procedure

1. Obtain the sample in accordance with IM 327.

2. Dampen the inside of the cone and place it on a dampened, rigid, non-absorbent surface that is level and firm.

3. Stand on both foot pieces in order to hold the mold firmly in place.

4. Fill the cone 1/3-full in volume, to a depth of 2 5/8 in. (67 mm) in depth.

5. Consolidate the layer with 25 strokes of the tamping rod, using the rounded end. Distribute the strokes evenly over the entire cross section of the concrete. For this bottom layer, incline the rod slightly and make approximately half the strokes near the perimeter, and then progress with vertical strokes, spiraling toward the center.

6. Fill the cone 2/3-full in volume, to a depth of 6 1/8 in. (155 mm) in depth.

7. Consolidate this layer with 25 strokes of the tamping rod, just penetrating into, but not through, the bottom layer. Distribute the strokes evenly.

8. Fill the cone to overflowing.

9. Consolidate this layer with 25 strokes of the tamping rod, just penetrating into, but not through, the second layer. Distribute the strokes evenly. If the concrete falls below the top of the cone, stop, add more concrete, and continue rodding for a total of 25 strokes. Keep an excess of concrete above the top of the mold at all times. Distribute strokes evenly as before.

10. Strike off the top surface of concrete with a screeding and rolling motion of the tamping rod.

11. Clean the overflow concrete away from the base of the mold.

12. Remove the mold from the concrete by raising it carefully in a vertical direction. Raise the mold 12 in. (300 mm) in 5 ± 2 seconds by a steady upward lift with no lateral or torsional motion being imparted to the concrete.

    The entire operation from the start of the filling through removal of the mold shall be carried out without interruption and shall be completed within an elapsed time of 2 1/2 minutes.

13. Invert the slump cone and set it next to the specimen.

14. Lay the tamping rod across the mold so it is over the test specimen.

15. Measure the distance between the bottom of the rod and the displaced original center of the top of the specimen to the nearest 1/4 in. (6 mm).

NOTE: If a decided falling away or shearing off of concrete from one side or portion of the mass occurs, disregard the test and make a new test on another portion of the sample. If two consecutive tests on a sample of concrete show a falling away or shearing off of a portion of the concrete from the mass of the specimen, the concrete probably lacks the plasticity and cohesiveness necessary for the slump test to be applicable.

Iowa Department of Transportation
Office of Materials

October 17, 2006
Supersedes April 19, 2005

AIR CONTENT OF FRESHLY MIXED CONCRETE BY PRESSURE

SCOPE

This test method describes the procedure for determining the air content of freshly mixed concrete by one form of pressure method.

PROCEDURE

NOTE: Certain coarse aggregates in east central Iowa will cause air meter readings to indicate higher air content than is actually in the concrete. An aggregate correction factor must be applied to correct the air content. The District Materials Engineer will supply the correction factor when using these aggregates. AASHTO T152 requires an aggregate correction factor for all concrete; however, it typically is not large enough for most aggregates to require adjustment.

A. Apparatus

1. All apparatus used shall incorporate the requirements of Section 2a, under Apparatus, of AASHTO Designation T-152. While there are several meters, which meet these requirements, the directions given below in B., Test Procedure, apply to the Washington-type presently in use by the Iowa Department of Transportation.

   NOTE: It is recommended that a calibration be performed prior to any new pour.

B. Test Procedure (For use with Washington-Type Air Meter)

1. Calibration of Apparatus (Water Method)

   a. To calibrate the apparatus, first fill the measuring bowl with water, then withdraw measured amounts of water corresponding to definite percentages of air in the base. After each increment of water is withdrawn, pump air into the head until a predetermined initial pressure line on the dial is reached.

   b. Open the operating valve and read the air content directly from the dial. The reading on the dial is compared to the known amount of air in the base and suitable corrections made. Consult air meter box lid for more explicit calibration instruction.

2. Calibration of Apparatus (Plug Method)

   a. To calibrate the apparatus, first fill the measuring bowl with water, and then insert the calibration plug. Place the head on the unit and pump air into the head until a predetermined initial pressure line on the dial is reached.

b. Using a rubber syringe, inject water through one petcock until all the air is expelled through the opposite petcock. Jar the base to insure removal of all air. Leave petcocks open.

c. Stabilize dial hand at proper initial pressure line by pumping or bleeding off, as needed, while lightly tapping the backside of the dial with the fingers. Inject water through the petcock again to make sure all the air is expelled.

d. Close both petcocks and press down on the thumb lever exhausting air into the base. The dial should read 5% air for each calibration plug in the measuring bowl with a maximum variation of ±0.2% air. Two plugs may also be used to get a 10% air reading. The gauge is set to 5.0% when calibrated in the Central Laboratory. If the reading is off by more than ±0.2% at either 5% or 10% setting, the gauge should be returned to the Central Laboratory for repair.

3. Operation of Apparatus (Determination of Air Content of Concrete)

a. Fill the base with a sample of fresh concrete placing the concrete in the base in three equal layers. Rod each layer twenty-five times with the tamping rod provided with the meter. For slumps less than 1 in. (25mm), the sample may need to be consolidated by internal vibration.

b. Do not allow the rod to forcibly strike the bottom of the base while rodding the bottom layer. The rod should just penetrate the underlying layer when rodding the upper layers. Care should also be taken to avoid hitting the top edge of the base with the tamping rod.

c. Tap the sides of the base 10-15 times with a rubber mallet after rodding each layer to close the holes left by the rod.

d. A clean, smooth surface on the top edge of the base is necessary to insure a tight seal with the cover. Strike off base, level full, with the straight edge furnished. Wipe the top edge of the base clean to insure a tight seal with the cover.

e. Clamp cover on with petcocks open.

f. With the built in pump, pump air into the air chamber atop the cover until the pressure indicator points to the proper initial pressure line on the gauge. **NOTE:** The pump stem may need a light coat of oil to slide freely. Too much oil on the stem will fill the pump chamber and block the air valve causing the pump to fail.

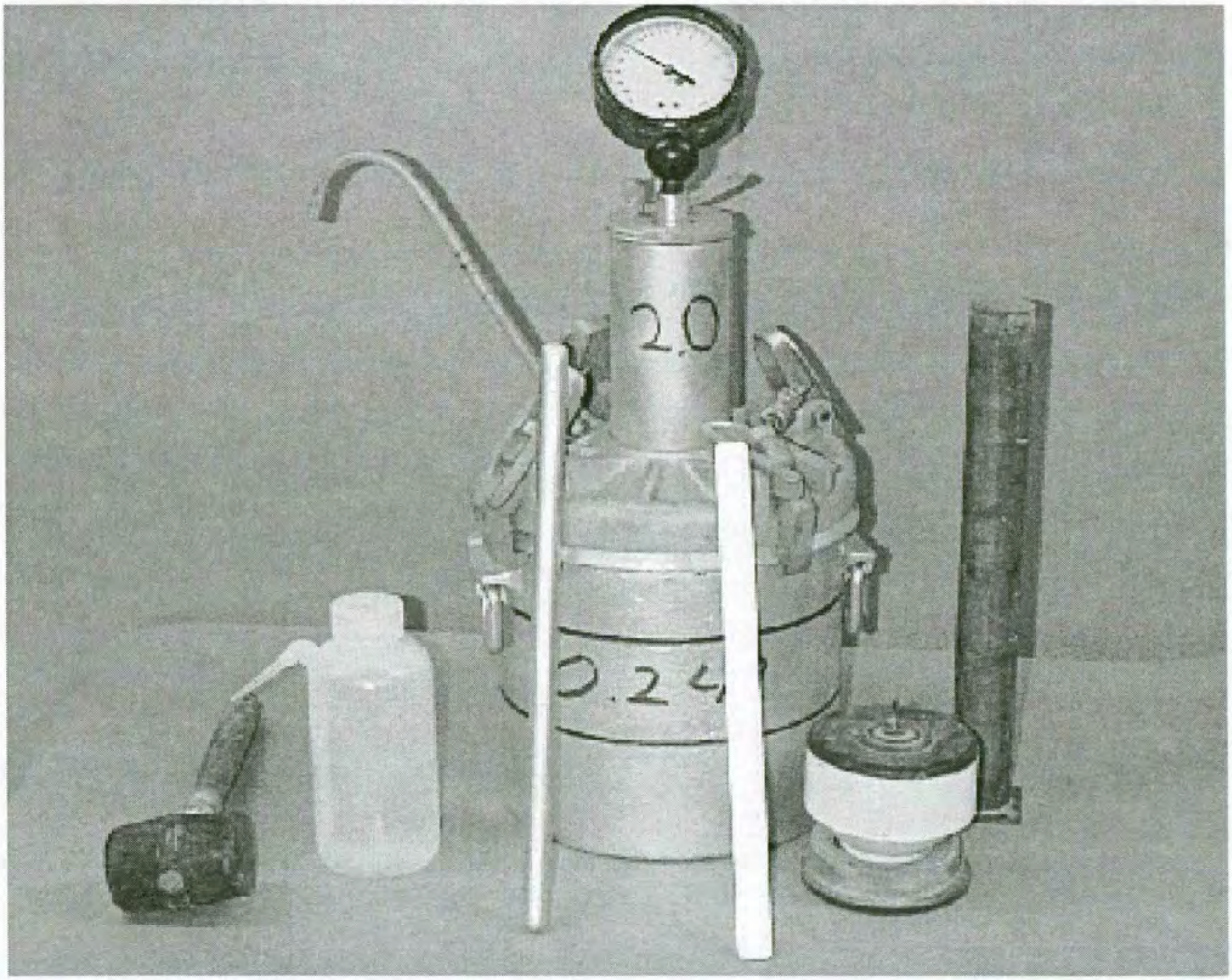
g. Using a rubber syringe, inject water through one petcock until all the air is expelled through the opposite petcock. Jar the base to insure removal of all air. Leave petcocks open. **NOTE:** Use care if injecting water through opposite petcock to not add air bubbles. When jarring the base to remove the air, the base shall not be tilted more than 2 inches (50 mm) from horizontal.

The sequence of Steps f. and g. may be interchanged without adversely effecting the test result.

h. Stabilize dial hand at the proper initial pressure line by pumping or bleeding off, as needed, while lightly tapping the backside of the dial with the fingers. Inject water through the petcock again to make sure all the air is expelled.

i. Close both petcocks. Press down on lever to release air into the base. Hold lever down a few seconds lightly tapping the backside of the dial with your fingers until the dial stabilizes. Observe the dial reading before letting up on the lever. Record the dial reading.

j. Open petcocks to release pressure, and then remove cover. Empty the concrete from base, clean up base, cover with petcocks left opened.



Air Meter and Calibrating Accessories

SAMPLING FRESHLY MIXED CONCRETE

SCOPE

This procedure provides instruction for obtaining samples of fresh concrete for new construction or repair. Sources covered include grade, ready mix truck, mobile mixer, pump or conveyor placement systems, and concrete slab as placed.

SIGNIFICANCE

Testing fresh concrete in the field begins with obtaining and preparing the sample to be tested. Standardized procedures for obtaining a representative sample from various types of mixing and/or agitating equipment have been established. Specific time limits regarding when tests for temperature, slump, and air content must be started and for when the molding of test specimens must begin are also established.

Technicians must refrain from obtaining the sample too quickly. Doing so would be a violation of the specifications under which the concrete is being supplied and it may result in a nonrepresentative sample of concrete. Every precaution must be taken to obtain a sample that is truly representative of the entire batch and then to protect that sample from the effects of evaporation, contamination, and physical damage.

PROCEDURE

A. Apparatus

1. Wheelbarrow or other nonabsorbent container
2. Cover for wheelbarrow or container (plastic, canvas, or burlap)
3. Shovel
4. 5-gal. (19 L) bucket for water

B. Testing Procedure

For acceptance testing, obtain representative samples from the last practical point before incorporation, but before consolidation.

1. Sampling from Grade

   Sample after the concrete in the transport vehicle has been discharged onto the grade. To ensure a representative sample, obtain concrete from at least five different locations in the pile and combine into one test sample. Avoid contamination with subgrade material or prolonged contact with absorptive subgrade.

2. Sampling from Ready Mix Truck

   Sample the concrete after a minimum of 1/2 yd.^{3} (1/2 m^3) of concrete has been discharged. Do not obtain samples until after all of the water has been added to the mixer. Do not obtain samples from the very first or last portions of the batch discharge. Sample by repeatedly passing a receptacle through the entire discharge stream or by completely diverting the discharge into a sample container. Regulate the rate of discharge of the batch by the rate of revolution of the drum and not by the size of the gate opening.

3. Sampling from Mobile Mixer

   Discharge the concrete into a container or power buggy sufficiently large enough to accommodate the entire batch. Secure a representative sample after the batch has been deposited by obtaining one shovel full, more or less, from each of at least three different positions in the container or power buggy.

4. Sampling from Pump or Conveyor Placement Systems

   Sample after a minimum of 1/2 yd.^{3} (1/2 m^3) of concrete has been discharged. Do not obtain samples until after all of the pump slurry has been eliminated. Sample by repeatedly passing a receptacle through the entire discharge system or by completely diverting the discharge into a sample container. Do not lower the pump arm from the placement position to ground level for ease of sampling, as it may modify the air content of the concrete being sampled. Do not obtain samples from the very first or last portions of the batch discharge.

5. Sampling from Concrete Slab as Placed

   Mark the approximate location of concrete placed on grade and sampled for air content. After the paver has passed the marked location, remove the sample from the slab, approximately in line with a vibrator and within an 18 in. x 18 in. (500 mm x 500 mm) square area to a depth approximately two-thirds of the pavement thickness. The sample should be obtained a minimum of 12 in. (300 mm) from the edge of slab to prevent extra handwork in maintaining the pavement edge.

Transport samples to the place where fresh concrete tests are to be performed and specimens are to be molded. Protect the sample from direct sunlight, wind, rain, and sources of contamination.

Complete test for temperature and start tests for slump and air content within five minutes of obtaining the sample. Complete tests as quickly as possible. Start molding specimens for strength tests within 15 minutes of obtaining the sample.

October 17, 2006
Supersedes April 20, 2004

Matls. IM 328

MAKING, PROTECTING & CURING CONCRETE FLEXURAL STRENGTH FIELD SPECIMENS

SCOPE

This method covers procedures for making, protecting and curing flexural strength field specimens sampled from concrete being used in construction.

PROCEDURE

A. Apparatus

1. 6 in. x 6 in. x 20 in. (152 mm x 152 mm x 508 mm) beam mold. The molds provided will comply with the requirements of AASHTO T-23 for dimensions, construction, materials, smoothness and straightness.

2. Shovel (square point).

3. Rubber hammer or equivalent

4. Wood float or equivalent.

B. Test Procedure

Specimens molded for determination of compliance with strength specifications shall be cast and cured according to AASHTO T-23.

1. Secure the concrete sample in accordance with IM 327, Method of Sampling Concrete for Slump, Air Content and Strength Testing. Specimens shall be molded on a level, rigid, horizontal surface as near as practicable to the place where they will be stored during the first 20 ± 4 hours. All jarring, striking, tilting or scarring (however, preliminary markings with a nail or other sharp object within 4 in. (100 mm) of the beam end will be permitted) of the specimen surface shall be avoided if moving immediately after striking off is necessary. Place the concrete in the mold in two equal layers and thoroughly spade each layer with the shovel. Use special care consolidating the sides and after spading each layer strike the sides of the form with a rubber hammer or equivalent until the spading marks are closed. Strike off the excess concrete and smooth the surface with as little manipulation of the concrete as possible. Excessive spading and smoothing must be avoided.

   When consolidating by vibration, fill concrete in one layer. Insert the vibrator at intervals not exceeding 6 in. (150 mm) along the centerline of the long dimension of the specimen, avoiding the exact center of the beam. Sufficient vibration is achieved as soon as the surface has become relatively smooth. Avoid overvibration which may cause segregation. After vibrating, strike the sides of the form with a rubber hammer 10 to 15 times to release any air bubbles that may have been trapped.

When consolidating by rodding, specimens shall receive 60 roddings evenly distributed over two equal layers with a 5/8 in. (16 mm) rod. The bottom layer shall be rodded throughout its depth. For the upper layer, the rod shall penetrate 1 in. (25 mm) into the underlying layer. After rodding each layer, strike the sides of the form with a rubber hammer 10 to 15 times to release any air bubbles that may have been trapped.

2. Immediately after smoothing protect the freshly made beam against moisture loss by evaporation, against rapid temperature increase caused by the combined effects of hot weather, bright sun, and the chemical hydration process and against freezing or near freezing temperature. It is generally practical to apply the same protection to the test specimen that is applied to the represented pavement or structure. This is not absolutely necessary, however, so long as the three conditions outlined above are satisfied.

3. On the day after the specimens are made and when they have reached an age of 16 to 24 hours, move the specimens while still in the molds to the location of final storage and curing, generally the concrete plant inspector's laboratory. The beams, even with the molds in place, must be handled carefully to avoid injury. A slight jar or bump may cause cracking which may be invisible at the time but which may become apparent with later handling or as premature failure during testing.

4. Remove the specimens from the molds (generally at the plant), clean, oil, reassemble and return the molds to the sampling location (generally at the direction of the paving or grade inspector).

5. Assign a chronological number, which corresponds with the day the beam was made to each beam. Begin with number 1. When more than one beam is made on a given day use capital letters A, B, C, etc., following the number which identifies the day to identify the daily making sequence. When two or more mixers are operated on separate sections of a project use a separate letter identification preceding the number assigned to the beams made from each respective mixer. Clean the beam and mark the numbers on the smooth bottom of the beam as cast. The numbers should be neatly made, and should be 4 to 8 inches (100 to 200 mm) from the end of the beam. When freshly marked specimens are being placed in storage, cover the marked section with a small board to keep the sand out of the marking.

6. Store the specimens in a wetted sand filled pit of adequate size to accommodate all specimens made on the project or in lime saturated water. A pit 4' x 6' x 18" (1.2 m x 1.8 m x 0.5 m) is normally adequate. Place the specimens on a reasonable smooth bed of sand and cover them completely with additional sand. If the temperature in the sand-filled pit drops below 40°F (4°C) remove the specimens and place them under wetted burlap in a heated enclosure or in lime saturated water. Maintain the specimens in a continually wet condition, and above 40°F (4°C) until they are tested. **NOTE:** Lime-saturated water is prepared by mixing 1 ounce (28 gm) of hydrated lime with 1 gallon (3.8 liters) of water.

Concrete Beam Mold

WEIGHT PER CUBIC FOOT, YIELD & AIR CONTENT (GRAVIMETRIC) OF CONCRETE

SCOPE

This procedure covers the determination of density, or unit weight of freshly mixed concrete. It also provides formulas for calculating the volume of concrete produced from a mixture of known quantities of component materials.

SIGNIFICANCE

The unit weight is a useful tool in determining the concrete batch yield and air content. Since air adds no weight to the concrete and only occupies a volume, the unit weight of the concrete gives a very good indication of the air content of the concrete. Normal weight concrete is in the range of 140 - 150 lbs./cu. ft. For normal weight concrete, a change in unit weight of 1.5 lbs./cu. ft. relates to approximately a 1 percent change in air content. Using the unit weight to indicate air content can also prevent any discrepancies between air meters.

PROCEDURE

A. Apparatus

1. Measure: May be the base of the air meter used for determining air content from IM 318. Otherwise, it shall be a metal container meeting the requirements of AASHTO T-121. The capacity and dimensions of the measure shall conform to those specified in Table 1.

2. Balance or scale: Accurate to 0.3 percent of the test load at any point within the range of use.

3. Tamping Rod: 5/8 in. (16 mm) diameter and approximately 24 in. (600 mm) long, having a hemispherical tip.

4. Vibrator: 7000 vibrations per minute, 0.75 in. to 1.50 in. (19 mm to 38 mm) in diameter, at least 3 in. (75 mm) longer than the section being vibrated for use with low slump concrete.

5. Scoop

6. Strike-off Plate: A flat rectangular metal plate at least 1/4 in. (6 mm) thick or a glass or acrylic plate at least 1/2 in. (12 mm) thick, with a length and width at least 2 in. (50mm) greater than the diameter of the measure with which it is to be used. The edges of the plate shall be straight and smooth within tolerance of 1/16 in. (1.5mm).

7. Mallet: With a rubber or rawhide head having a mass of 1.25 ± 0.5 lb. (0.57 ± 0.23 kg) for use with measures of 1/2 $ft.^3$ ($0.014\ m^3$) or less, or having a mass of 2.25 ± 0.5 lb. (1.02 ± 0.23 kg) for use with measures of 1 $ft.^3$ ($0.028\ m^3$).

Table 1
Dimensions of Measures

Capacity M^3 (ft. ^{3})	Inside Diameter mm (in.)	Inside Height mm (in.)	Minimum Thickness mm (in.) Bottom	Wall	Nominal Maximum Size of Coarse Aggr. mm(in.)
0.0071	203 ± 2.54	213 ± 2.54	5.1	3.0	25
(1/4)	(8.0 ± 0.1)	(8.4 ± 0.1)	(0.20)	(0.12)	(1)
0.0142	254 ± 2.54	279 ± 2.54	5.1	3.0	50
(1/2)	(10.0 ± 0.1)	(11.0 ± 0.1)	(0.20)	(0.12)	(2)
0.0283	356 ± 2.54	284 ± 2.54	5.1	3.0	76
(1)	(14.0 ± 0.1)	(11.2 ± 0.1)	(0.20)	(0.12)	(3)

Measure may be the base of the air meter used in IM 318.

B. Calibration of Measuring Bowl

1. Determine the weight of the dry measure and strike-off plate.
2. Fill the measure with water at a temperature between 16ºC and 29ºC (60ºF and 85ºF) and cover with the strike-off plate in such a way as to eliminate bubbles and excess water.
3. Wipe dry the measure and cover plate, being careful not to lose any water from the measure.
4. Determine the weight of the measure, strike-off plate, and water in the measure.
5. Determine the weight of the water in the measure by subtracting the weight in Step 1 from the weight in Step 4.
6. Measure the temperature of the water and determine its density from Table 2, interpolating as necessary.
7. Calculate the volume of the measure, V_m, by dividing the weight of the water in the measure by the density of the water at the measured temperature, from Table 2.

Example: $V_m = \dfrac{15.57}{62.274}$ $V_m = 0.250 \text{ ft.}^3$

Table 2
Unit Weight of Water
15°C to 30°C

°C	(°F)	kg/m^3	(lb./ft. ^{3})	°C	(°F)	kg/m^3	(lb./ft. ^{3})
15	(59.0)	999.10	(62.372)	23	(73.4)	997.54	(62.274)
15.6	(60.0)	999.01	(62.366)	23.9	(75.0)	997.32	(62.261)
16	(60.8)	998.94	(62.361)	24	(75.2)	997.29	(62.259)
17	(62.6)	998.77	(62.350)	25	(77.0)	997.03	(62.243)
18	(64.4)	998.60	(62.340)	26	(78.8)	996.77	(62.227)
18.3	(65.0)	998.54	(62.336)	26.7	(80.0)	996.59	(62.216)
19	(66.2)	998.40	(62.328)	27	(80.6)	996.50	(62.209)
20	(68.0)	998.20	(62.315)	28	(82.4)	996.23	(62.192)
21	(69.8)	997.99	(62.302)	29	(84.2)	995.95	(62.175)
21.1	(70.0)	997.97	(62.301)	29.4	(85.0)	995.83	(62.166)
22	(71.6)	997.77	(62.288)	30	(86.0)	998.65	(62.156)

C. Testing Procedure

NOTE: There are two methods of consolidating the concrete – rodding and vibration. If the slump is greater than 3 in. (75 mm), consolidation is by rodding. When the slump is 1 to 3 in. (25 to 75 mm), internal vibration or rodding can be used to consolidate the sample, but the method used must be that required by the agency in order to obtain consistent, comparable results. For slumps less than 1 in. (25 mm), the sample may be consolidated by internal vibration.

1. Determine the weight of the dry measure.
2. Obtain the sample in accordance with IM 327. Testing may be performed in conjunction with IM 318. When doing so, this test should be performed prior to IM 318. **NOTE:** If the two tests are being performed using the same sample, this test shall begin within five minutes of obtaining the sample.
3. Dampen the inside of the measure.
4. Fill the measure approximately 1/3-full with concrete.
5. Consolidate the layer with 25 strokes of the tamping rod, using the rounded end. Distribute the strokes evenly over the entire cross section of the concrete. Rod throughout its depth without hitting the bottom too hard.
6. Tap the sides of the measure smartly 10 to 15 times with the mallet to close voids and release trapped air.
7. Add the second layer, filling the measure about 2/3-full.
8. Consolidate this layer with 25 strokes of the tamping rod, penetrating about 1 in. (25 mm) into the bottom layer.
9. Tap the sides of the measure smartly 10 to 15 times with the mallet.

10. Add the final layer, slightly overfilling the measure.
11. Consolidate this layer with 25 strokes of the tamping rod, penetrating about 1 in. (25 mm) into the second layer.
12. Tap the sides of the measure smartly 10 to 15 times with the mallet.

    NOTE: The measure should be slightly over full, about 1/8 in. (3 mm) above the rim. If there is a great excess of concrete, remove a portion with the scoop. If the measure is under full, add a small quantity. This adjustment may be done only after consolidating the final layer and before striking off the surface of the concrete.

13. Strike off the surface of the concrete and finish it smoothly with a sawing action of the strike-off plate using great care to leave the pot just full. The surface should be smooth and free of voids.
14. Clean off all excess concrete from the exterior of the measure including the rim.
15. Determine and record the weight of the measure and the concrete.
16. If the air content of the concrete is to be determined, proceed to Step E of IM 318.

D. Calculations

Unit Weight (density) – Calculate the net weight, W_3, of the concrete in the measure by subtracting the weight of the measure, W2, from the gross weight of the measure plus the concrete, W1. Calculate the density, ρ, by dividing the net weight, W_3, by the volume, V_m, of the measure as shown below.

$$W_1 - W_2 = W_3 \qquad \text{Example: } 42.8 - 7.6 = 35.2 \text{ lb.}$$

$$\rho = \frac{W_3}{V_m} \qquad \underline{\text{Example}}: \ \rho = \frac{35.2\text{ lb.}}{0.249\text{ cu. ft.}} = 141.37/\text{cu.ft.}$$

Theoretical unit weight (air-free basis) – The theoretical unit weight, T, is the total weight of materials batched divided by the absolute volume of materials batched on an air-free basis.

Using the actual batch weights and absolute volumes, sum the following:

	Weight	SpGr	Abs. Vol.	Example Abs. Vol. Calc.
Cement	477	3.14	0.090	= 477/(3.14 x 62.4 x 27)
Fly Ash	84	2.68	0.019	
Total Water (Plant, aggr., grade)	220	1.00	0.131	

Fly Ash	84	2.68	0.019
Total Water (Plant, aggr., grade)	220	1.00	0.131

Aggregate, SSD Dry Batch Weights			
Fine	1246	2.65	0.279
Intermediate	364	2.57	0.084
Coarse	1451	2.57	0.335
Total	3842		0.938

$$\text{Theoretical unit weight (cu. Ft.)} = \frac{\text{Batch weight}}{\text{Abs. Vol. x 27}}$$

$$= \frac{3842}{0.938 \times 27}$$

$$= 151.7 \text{ lbs./cu. ft.}$$

Air Content – Air content is calculated by subtracting the unit weight, ρ, from the theoretical unit weight, T, divided by the theoretical unit weight, T, multiplied by 100 as shown below.

$$A = \frac{T - \rho}{T} \times 100$$

Example:

$$A = \frac{151.7 \text{ lbs./cu. yd.} - 141.37 \text{ lbs./cu. yd.}}{151.7 \text{ lbs./cu. yd.}} \times 100 = 6.8\%$$

Theoretical Unit Weight = 151.7

The theoretical unit weight, T, is the total weight of materials batched divided by the absolute volume of materials batched on an air free basis.

Relative Batch Yield – Calculate the yield, Y, or volume of concrete produced per cubic yard, by dividing the total weight of the cubic yard batched, W_t, by 27, then dividing by the density, ρ, of the concrete as shown below.

$$Y = \frac{W_1 \div 27}{\rho}$$

Example:

$$Y = \frac{3842 \text{ lbs. batched per cu. yd.} \div 27}{141.37 \text{ lb./cu. ft.}} = 1.007 \text{ cu. yd.}$$

MEASURING LENGTH OF DRILLED CONCRETE CORES

SCOPE

This method covers the procedure for determining the length of a core drilled from a PC Concrete structure, particularly from a PC Concrete pavement. The procedure is a modification of AASHTO T 148.

PROCEDURE

A. Apparatus

1. The apparatus consists of a calipering device that will measure the length of axial elements of the core.
2. The apparatus is designed so the specimen is held with its axis in a horizontal position by guide rods when making circumferential measurements, and a stand placed upon the guide rods for making a center measurement. The device is equipped with an auxiliary wheel that rests on the specimen and is calibrated such that one-half of a revolution of the wheel represents one-eighth the circumference of a 4 in. (100 mm) diameter core.
3. The device is constructed so the specimen is brought into contact with a single flat-faced probe 3/8 in. (10 mm) in diameter mounted on a fixed end of the device.
4. The measuring rod, which makes contact with the end surface of the specimen, is rounded to a radius of 1/8 in. (3 mm) and is mounted on a moveable plate, which in turn is mounted on guide rods. One guide rod is provided with a scale on which the length readings are made. The graduations of the scale are spaced at 0.10 in. (2.5 mm) intervals.
5. The apparatus provides for the accommodation of specimens of different nominal lengths over a range of 4 to 11 in. (100 mm to 275 mm).
6. The calipering apparatus is designed so it is possible to make a length measurement at the center of the specimen and at eight additional points spaced equally along the circumference of a circle whose center point coincides with the end area of the specimen and whose radius is not less than one-half, nor more than three-fourths, of the radius of the specimen.
7. The apparatus is stable and sufficiently rigid to maintain its shape and alignment without a distortion or deflection of more than 0.01 in. (0.25 mm) during all normal measuring operations.

B. Test Specimens

1. Cores used as specimens for length measurement must be in every way representative of the concrete in the structure from which they are removed. The specimen is to be drilled with the axis normal to the surface of the structure, and the ends must be free from all conditions not typical of the surfaces of the structure. Cores that show abnormal defects or that have been damaged appreciably in the drilling operation should not be used.

C. Test Procedure

1. Before any measurements of the core length are made, calibrate the apparatus with suitable gauges so errors caused by mechanical imperfections are known. When these errors exceed 0.01 in. (0.25 mm), suitable corrections must be applied to the core length measurements.

2. Place the stand on the guide rods and place the specimen on the stand for the center point measurement. The smooth end of the core, that is, the end that represents the upper surface of a pavement slab or a formed surface in the case of other structures is to be positioned facing the fixed end of the measuring device. Bring the specimen into contact with the stud in the fixed end, slide the movable plate until it is in contact with the specimen and record the length.

3. Remove the stand, place the specimen directly on the guide rods and make another measurement as described in C2.

4. Place the small auxiliary wheel on the specimen so the scribed marks on the wheel are in alignment. Rotate the specimen until the marks are again in alignment (1/2 revolution of the wheel) and make another measurement. Continue in this manner until eight measurements in addition to the center measurements have been made.

5. Read each of the nine measurements directly to 0.10 in. (2.5 mm), and interpolate to the nearest 0.05 in. (1 mm) by estimation.

6. If, in the course of the measuring operation, it is discovered that at one or more of the eight circumferential measuring points the surface of the specimen is not representative of the general plane of the core end because of a small projection or depression, rotate the specimen slightly about its axis, and make another set of measurements with the specimen in the new position. If the center measurement is not representative of the general plane of the core end, it should not be used in computing the length of the core.

7. If some damage from drilling is apparent, no measurements are to be made in the damaged area. Reposition the core to avoid the areas when measuring the length. If these areas cannot be avoided, the length measurements made in these areas are not to be used in computing the length of the core. In no case, are fewer than seven measurements to be used in determining the core length.

D. Report

1. The individual observations are to be recorded to the nearest 0.05 in. (1 mm) and the average of the nine measurements expressed to the nearest 0.05 in. (1 mm) and shall be reported as the length of the concrete core.

E. Precautions

1. Be careful to move the core away from the stud in the fixed end slightly when turned, so the stud will retain its proper length and shape.

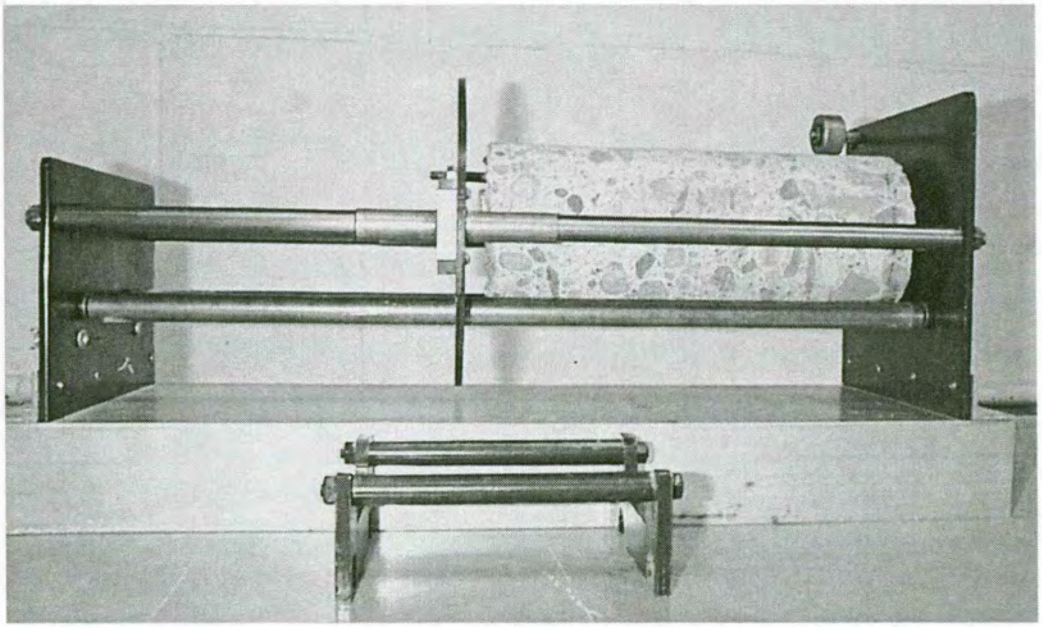


Figure 1. Concrete Core in Measuring Apparatus

April 19, 2005
Supersedes April 25, 2000

Matls. IM 375

DETERMINING FLOW OF GROUT MIXTURES
(FLOW CONE METHODS)

SCOPE

This method of test covers the procedure to be used both in the laboratory and in the field for determining the flow of grout mixtures by measuring the time of efflux of a specified volume of grout from a standardized flow cone.

The procedure is a modification of Corp. of Engineers Method CRD-C611-80.

APPARATUS

1. Flow cone as specified in the Corp. of Engineers Method CRD-C611-80
2. Stopwatch accurate and readable to 0.2 seconds
3. Level
4. Calibration jug or container to hold a quantity of water equal to 2 qt. (1725 mL)

CALIBRATION OF CONE

1. The flow cone shall be firmly mounted in such a manner that the top will be level and the cone free from vibration (use level, rigid, horizontal surface).
2. Level the cone by adjusting the mounting forks.
3. Close the discharge tube of the cone by placing a finger over the lower end. (Be sure not to disturb the leveled cone.)
4. Introduce 1725 ± 1 mL of water into the cone.
5. Adjust the pointer so that the point just comes into contact with the water.

SAMPLE

The test sample shall consist of 1725 ± 1 mL of grout.

PROCEDURE

1. Moisten the inside surface of the flow cone.
2. Place a finger over the discharge opening.
3. Introduce grout into the cone until the grout surface rises into contact with the pointer.
4. Start the stopwatch and remove the finger simultaneously.
5. Stop the stopwatch at the first break in the continuous flow of grout from the discharge opening (when the cone is essentially empty).
6. Read time of efflux of the grout (which is the time indicated by the stopwatch).

NOTE 1: If there is a break in the continuity of discharge prior to essential emptying of the cone, it is an indication that the grout is too thick to be properly tested for flow.

NOTE 2: If the sand used in the grout mixture is larger than No. 4 (4.75 mm) in size, then the sample should be sieved through a No. 4 (4.75 mm) sieve cloth prior to being introduced to the flow cone.

REPORT – (See Figure 1 for an Example.)

1. Average time of efflux to the nearest second.
2. Composition of the sample
3. Information and observation of the physical characteristics of the sample

FIGURE 1

IOWA DOT DISTRICT 1 LAB
FLOWABLE MORTAR

LAB NUMBER: 1AS4:008
PROJECT NUMBER: CONTRACT NUMBER:
COUNTY: POLK DESIGN:
CONTRACTOR:
MATERIAL: FINE SAND
SOURCE: HALLETT-JOHNSON
UNIT OF MATERIAL: CEMENT-LAFARGE, FLYASH-COUNCIL BLUFFS
QUANTITY: 50 LB BAG
PRODUCER: GNA CONCRETE
SAMPLED BY: SENDER'S NUMBER
DATE SAMPLED: 5/12/04 DATE RECEIVED: 5/12/04 DATE REPORTED: 5/14/04

SIEVE SIZE	PERCENT PASSING
3/8"	100
#4	99
#8	92
#16	78
#30	44
#50	8.2
#100	0.9
#200	0.5

DISPOSITION: COMPLIES WITH THE FOLLOWING PROPORTIONS: 400 LBS. FLYASH, 100 LBS. CEMENT, 2600 LBS. SAND. FLOWABILITY OF 16.10 SEC OBTAINED WITH 68 GAL/YD³ H20.

COPIES: DISTRICT 1
DISTRICT 1 MATERIALS LAB
OFFICE OF MATERIALS
S. TWOHEY
J. HART
OFFICE OF CONSTRUCTION
GNA CONCRETE

SIGNED: KEVIN JONES, PE
MATERIALS TESTING ENGINEER

October 17, 2006
Supersedes April 18, 2006

TESTING THE STRENGTH OF PORTLAND CEMENT CONCRETE USING THE MATURITY METHOD

GENERAL

This IM outlines the procedure for using the maturity concept as a nondestructive method to determine concrete strength.

This is a two-step procedure. First, a relationship must be established between the maturity values and the concrete strength as measured by destructive methods (that is, through testing of beams or cylinders). The development of the maturity-strength curve shall be done in the field at the beginning of construction using project materials and the project proportioning and mixing equipment. The second step is the instrumentation of the concrete to be measured. Temperature probes are installed in the concrete and the temperature is measured. From those measurements, along with the age at which the measurements were taken, maturity values are determined. A maturity meter or temperature-measuring device and a computer or calculator may also be used to determine the maturity values.

The contractor and the agency shall jointly develop a plan for performing the maturity testing. The plan shall include:

1. The contractor shall be responsible for the development of the maturity curve. The curve development shall be monitored by the contracting agency.

2. The temperature monitoring process of the constructed pavement or structure shall be the responsibility of the contractor and shall be monitored by the contracting agency. Determining that sufficient strength has been achieved shall remain the responsibility of the engineer. The contractor shall provide documentation of maturity testing before a pavement section may be opened to traffic, a structure may be loaded, or the forms may be removed.

For concrete furnished from a construction or stationary mixer, which is in place prior to construction of the specified project, a maturity curve may be established ahead of actual construction of the specified project. The test specimens shall be cast with concrete made from the same plant and using the same materials source as will be used in the specified project. The agency shall be informed and have an opportunity to observe the development of the maturity curve.

THE MATURITY CONCEPT

The hydration of cement and gain in strength of the concrete is dependent on both curing time and temperature. Thus, the strength of the concrete may be expressed as some function of time and temperature. This information can then be used to determine the strength of concrete without conducting physical tests. The time-temperature function commonly used is the maturity concept proposed by Nurse-Saul (ASTM C1074),

$$M\ (^{o}C \text{ x hours}) = \sum \left[(T - T_0)\ \Delta t\right]$$

Where M is the maturity in °C-hours [M is also termed the time-temperature factor (TTF)], Δt is the time interval in hours (or days), T is the average concrete temperature during the time interval Δt, and T_0 is the datum temperature at which concrete ceases to gain strength with time. The value of T_0 = 14°F (-10°C) is most commonly used. As a result, Equation 1 becomes:

$$M\ (^{\circ}C \text{ x hours}) = \sum [(T + 10)\ \Delta t] \quad \text{Equation 2}$$

ESTABLISHMENT OF MATURITY-STRENGTH RELATIONSHIP

Precaution: When the concrete temperature is below 50°F (10°C), maturity strength development will cause over extended TTF values. Development of strength maturity relationship should be performed on concrete with temperatures above 50°F (10°C).

When air temperatures are expected to fall below 40°F (4°C), place the beams on a piece of foam board or plywood to prevent the cold ground from lowering beam temperatures. Placing insulation over the beams to retain heat may also be warranted.

To establish a maturity-strength relationship for a concrete mix, a maturity meter or other maturity and continual temperature profiling system and a hydraulic testing machine are needed. The following procedure shall be used: **(NOTE: Before using any maturity meter, check to be sure the datum temperature is set to -10°C.)** The procedure to check or change the datum temperature is included at the end of this IM

1. Cast a minimum of twelve (12) 6 in. x 6 in. x 20 in. (152 mm x 152 mm x 508 mm) beams, as per IM 328. Test the entrained air content and slump of the concrete being used to cast the beams, as per IM 327. Record these values. The concrete shall meet specifications. Since there is a direct relationship between w/c ratio and strength, the concrete used to develop the maturity-strength relationship shall be at the maximum w/c ratio expected during production. The beams shall be cast from a batch of at least $3m^3$ (3 cu. yd.).

2. Embed a thermocouple wire near each end of a test beam (when flexural strength is to be determined) to monitor the temperature. This beam will be the last to be tested. A probe shall be inserted near each beam end to the approximate mid-depth and such that they are approximately 3 in. (75 mm) from each side and each end. Loop the wire around the beam box handles to prevent the wire from being inadvertently pulled out of the beam. The average of the two readings will be used in the development of the maturity-strength curve. When a maturity meter is used, the meter computes the values. Twelve (12) test specimens shall be tested as described in #4 below.

3. Cast, cure, and test the beams at the plant site. Test in accordance to IM 316. This will allow a maturity meter to be protected from the weather and theft. The meter can be stored in a lab trailer or vehicle with the probes run outside to the beam in the sandpit. The beams shall be covered with plastic immediately after casting and prior to form removal. If possible, wet burlap should be placed over the surface of the beams under the plastic. The forms shall be removed the following day. Cure all beams in a pit of wet sand after form removal, until they are tested.

4. Determine maturity values and strength at four different ages. Test three specimens for strength at each age and calculate the average strength at each age. The maturity value shall be calculated from a temperature reading at the time the specimen is tested for strength. The tests shall be spaced such that they are performed at somewhat consistent intervals of time and span a range in strength that includes the opening strength desired. The table below gives suggested maturity values for each test of three standard mixture classes. This is only a guide and may need to be modified, depending on specific mixtures and conditions.

Approximate Maturity Values (TTF)

	Test 1	Test 2	Test 3	Test 4
A Mix	750	1500	2500	3500
B Mix	1500	3500	5500	7500
C Mix	750	1500	2500	3500
M Mix	600	1200	2000	3000

These values assume opening strength for pavements of 3.45 MPa (500 psi) for the A, B and C mixtures, and a five-hour opening for the M mixture with calcium chloride. If the maturity curve is intended for use in determining the time to begin joint sawing, testing must begin at lower maturity values.

For structural concrete, a minimum flexural strength of 3.8 MPa (550 psi) is required before concrete may be subjected to flexural loading. Strength requirements vary for determining when forms for roofs of culverts may be removed (See Article 2403.18). Testing intervals may need to be increased over those for paving.

The first test (Test 1), for Class C mixes, normally would be performed at an age of approximately twelve (12) hours when hot, summer temperatures prevail. During cooler conditions, the first test may be performed at the beginning of the day following the casting of test specimens.

Additional test specimens may be cast at a later time and tested at earlier ages to add data to the strength-maturity relationship as an aid to determining the appropriate time to saw.

5. Plot the measured strength against the corresponding values of maturity at different ages, as determined by the maturity meter or by hand methods. Use a computer program provided by the District Materials Concrete Technician to determine maturity-strength relationship. The TTF number corresponding to the opening strength or the flexural loading strength/form removal strength of the structure shall be used to determine when the pavement has reached opening strength or the structure has reached the required loading strength. An example of the Maturity-Strength Development form, generated by the computer program, is included at the end of this IM This form shall be signed by the contractor/contractor representative and reviewed by the DME. Copies will be provided to the Project Engineer, DME, Central Materials, PCC Engineer, and the contractor.

FIELD PROCEDURE

Equipment

1. 12 - 6 in. x 6 in. x 20 in. (152 mm x 152 mm x 508 mm) beam molds
2. 1 each shovel (square point), rubber hammer or equivalent, and wood float or equivalent
3. 1 each hydraulic testing machine – center point leading flexural
4. 1 each maturity meter or other maturity and temperature profiling system
5. 1 each hand-held thermometer or other continual temperature-monitoring device
6. Type T thermocouple wire
7. Connectors

Placement of the Temperature Probes

Strip the coating from each end of the two wires and twist the ends together before inserting them into the fresh concrete.

For pavements, insert the temperature probe into the concrete until the end is at approximately the pavement mid-depth and 1.6 feet (0.5 m) from the edge of the pavement. The wire ends are the points at which the temperature measurement is taken. Insertion may be accomplished by attaching the wire ends to a wooden dowel and embedding it into the slab. Check to ensure the concrete is consolidated around the dowel. The portion of the dowel that protrudes above the pavement should be cut or broken off after the testing is completed.

Probes may be placed at any point along the pavement slab. A minimum of two probes shall be placed in each day's placement. On days when there is a large difference between daytime high temperatures and nighttime low temperatures, placing additional probes near the beginning of the day's run and at a point near the midday location would provide helpful information. This would be helpful to those sawing the pavement as well as those determining the opening time. It has been found that the concrete does not always gain strength at the same rate. Therefore the concrete placed during the middle of the day can gain strength faster than the concrete placed at the beginning of the day.

For structures, a minimum of two probes shall be attached to the reinforcing steel near the edge at the upper corner of the exposed surface. (See Figure 1 at the end of this IM.) The probe should be wrapped around the rebar and taped with approximately 1 to 2 inches (25 to 50 mm) extending below the rebar to prevent the probe from damage and removal during concrete placement. The rebar should also be taped 2 to 3 inches (50 to 75 mm) on both sides of the probe location to prevent contact with the reinforcing steel. (See Figure 2 at the end of this IM.)

Data Collection

The other probe wire ends, not placed in the concrete, shall be connected to a plug, unless the temperature-measuring device must be connected to the probe directly with bare wires. The plug is then inserted into the maturity meter or thermal meter. Normally a thermal meter can be used to collect field data. Be careful to connect the copper wire to the copper plug prong (+).

When a thermal meter is used, the wire is connected to the meter each time a temperature is taken. Then the wire is disconnected and the value recorded. A Maturity Data Recording Sheet is provided at the end of this IM, which may be used to record the temperature readings and calculate the maturity values.

Do not disconnect the wire from the maturity meter until the test is completed. The data collection must be uninterrupted. Also the maturity meter must be protected from rain or water. If water finds its way inside the meter, permanent damage will result.

Once the wires are placed, an initial temperature of the concrete shall be taken and recorded, when a thermal meter is being used. Temperature readings should be taken in the morning and late afternoon, when one first arrives on the project and before one leaves for the day, as a minimum for standard A, B and C mixtures. For the fast-setting mixtures, readings should be taken every few hours, depending on weather conditions and mixture. If a maturity meter is being used, it should be connected to the probe as soon as possible to begin data collection.

Measuring the Maturity

For pavements, the maturity number can be read directly from the maturity meter or calculated from the temperature readings obtained by the thermal meter or other continual temperature-monitoring device. This number is then used to enter the strength-maturity chart that was established as described above and strength is then determined. **NOTE:** An instruction sheet will accompany each maturity meter. It is important to follow these instructions to initialize the instrument.

For structures, a maturity number can be read directly from the maturity meter or calculated from the temperature readings that shall be obtained from a continual temperature-monitoring device.

Implementation

For pavements, when used at the contractor's option, it is the intent of the procedure to use the maturity method to open the pavement to traffic from the very first day of paving, including the days of development of new curves.

Pavement placed on the first day during development of the strength-maturity curve may be opened when either of the following criteria has been met:

1. The TTF of the slab, or structure, meets or exceed the opening TTF as determined by the strength-maturity curve being developed.

2. At a particular test age, the average strength of the three beams used for development of the strength-maturity curve meets or exceeds the required opening strength.

For structures, since maturity is to be used on units exposed to flexural loading, the maturity curve should be developed early in the project during placement of concrete exposed to compressive stress. If this is not possible, concrete placed on the same day as development of the strength-maturity curve may be loaded at a particular age using either of the first day placement criteria required for pavements.

Validation

Once per month, validation tests shall be conducted to determine if concrete strength is being represented by the current maturity curve. Cast and cure three (3) beams using the same procedure and manner as used to develop the current maturity curve. Test all three beams as close as possible to the maturity value determined to represent the opening strength of the pavement or the flexural loading strength or form removal strength of the structure.

For pavements, if the average calculated strength value at the TTF the validation beams were tested is within the range of ±50 psi (0.34 MPa) of the original curve, the original curve shall be considered validated. If the average calculated strength at the TTF the validation beams were tested is lower than the minimum range (-50 psi (-0.34 MPa)) of the original maturity curve, a new maturity curve shall be developed. If the average calculated strength at the TTF the validation beams were tested is greater than the maximum range (+50 psi (+0.34 MPa)) of the original maturity curve, a new maturity curve may be developed at the contractor's option.

For structures, if the average calculated strength is greater than the original curve at the TTF the validation beams were tested, the original curve shall be considered validated. If the average calculated strength is less than the original maturity curve at the TTF the validation beams were tested, a new maturity curve shall be developed.

An example of the Validation of the Maturity Curve is included at the end of this IM. Signed copies shall be provided to the RCE, DME, Central Materials, PCC Engineer, and the contractor.

This validation procedure is a check to ensure the mix is basically the same as originally tested. If the test results indicate a new curve must be developed, this should be done in a timely manner. The curve currently being used shall be continued until new beams can be cast and at that point the implementation procedure described above shall be followed.

Factors Requiring a New Curve

Changes in material sources, proportions, and mixing equipment all affect the maturity value of a given concrete mixture. Development of a new maturity curve due to material source or proportion changes in a concrete mix may be waived by use of the validation procedure.

The following will require a new curve to be developed:

- The average calculated strength at the TTF the validation beams were tested is lower than the minimum range (-50 psi (-0.34 MPa)) of the original maturity curve (pavements only).
- The w/c ratio of the production concrete exceeds the w/c ratio of the concrete used to develop the strength-maturity curve by more than 0.02.

Calibration

Maturity meters shall be calibrated yearly to ensure proper temperature sensing. The calibration may be performed at the Central Laboratory, before the start of each construction. To ensure accurate temperature measurement, the maturity meter should also be checked periodically against a certified thermometer or other calibrated meter.

EXAMPLE

Maturity - Field Data

Project : FM-67(25)--55-67
County : MONONA
Contractor:

Date Placed: 8/12/1999
Mix: C-3WR-C-15

Maturity Curve #: 1

TTF Required for Opening or Loading : 1585

SITE 1	*Section of Pavement for Opening or Structural Unit for Loading by Maturity*	**Probe #**	1

Structual Unit or Probe Location From:

Probe Location To:

Date *Enter*	**Time** *Enter*	**Age (hours)** *Enter*	**Temp (deg C)** *Enter*	**TTF at age (deg C-hr)**	**Sum TTF (deg C-hr)**	**Air Temp (deg C)** *Enter*
08/12/99	09:00 AM	0.00	22	0	0	
	01:00 PM	4.00	29	142	142	
	05:30 PM	8.50	25	167	309	
08/13/99	08:00 AM	23.00	19	464	773	
	02:30 PM	29.50	22	198	971	
08/14/99	08:00 AM	47.00	21	551	1522	
	01:30 PM	52.50	20	168	1690	

$$TTF_i = \left(\frac{Temp_i + Temp_{i-1}}{2} + 10\right)(Age_i - Age_{i-1})$$

TTF: 1690 **Value in box should be greater than or equal to required TTF.**

SITE 2	*Section of Pavement for Opening or Structural Unit for Loading by Maturity*	**Probe #**	

Structual Unit or Probe Location - From:

To Probe Location:

Date *Enter*	**Time** *Enter*	**Age (hours)** *Enter*	**Temp (deg C)** *Enter*	**TTF at age (deg C-hr)**	**Sum TTF (deg C-hr)**	**Air Temp (deg C)** *Enter*
		0.00		0	0	

$$TTF_i = \left(\frac{Temp_i + Temp_{i-1}}{2} + 10\right)(Age_i - Age_{i-1})$$

TTF: **Value in box should be greater than or equal to required TTF.**

cc: RCE, Central Materials, Contractor

Contractor Representative

Agency Representative

Maturity - Field Data

Project : ______________________

County : ______________________

Contractor: ______________________

Date Placed: __________

Mix: __________

Maturity Curve #: __________

TTF Required for Opening or Loading : ☐

SITE 1	*Section of Pavement for Opening or Structural Unit for Loading by Maturity*	**Probe #**	
Structual Unit or Probe Location From:		**Probe Location To:**	

Date *Enter*	**Time** *Enter*	**Age (hours)** *Enter*	**Temp (deg C)** *Enter*	**TTF at age (deg C-hr)**	**Sum TTF (deg C-hr)**	**Air Temp (deg C)** *Enter*
		0.00		**0**	**0**	

$$TTF_i = \left(\frac{Temp_i + Temp_{i-1}}{2} + 10\right)(Age_i - Age_{i-1})$$

TTF: ☐ **Value in box should be greater than or equal to required TTF.**

SITE 2	*Section of Pavement for Opening or Structural Unit for Loading by Maturity*	**Probe #**	
Structual Unit or Probe Location - From:		**To Probe Location:**	

Date *Enter*	**Time** *Enter*	**Age (hours)** *Enter*	**Temp (deg C)** *Enter*	**TTF at age (deg C-hr)**	**Sum TTF (deg C-hr)**	**Air Temp (deg C)** *Enter*
		0.00		**0**	**0**	

$$TTF_i = \left(\frac{Temp_i + Temp_{i-1}}{2} + 10\right)(Age_i - Age_{i-1})$$

TTF: ☐ **Value in box should be greater than or equal to required TTF.**

cc: RCE, Central Materials, Contractor

____
Contractor Representative

____
Agency Representative

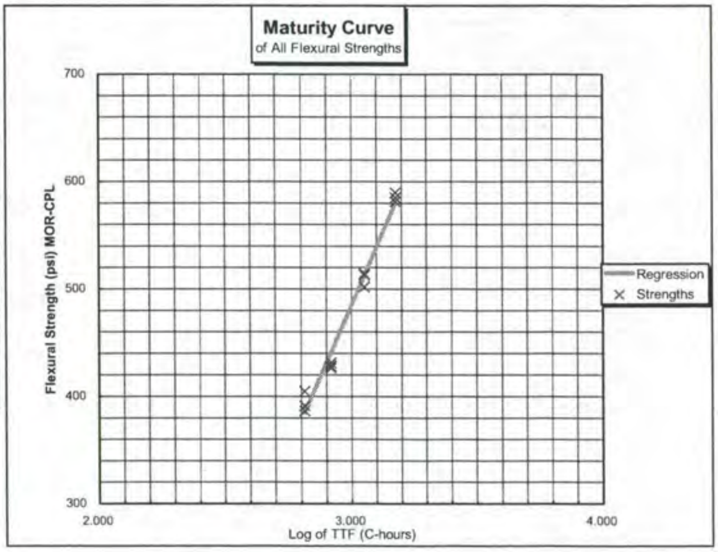
MATURITY - STRENGTH DEVELOPMENT MOR-CPL

COUNTY: Polk
CURVE #: 1
PROJ. #: IM-35-5(99)
MONITOR: Jenkins
REP/CONTRACTOR: Manatt's
INSPECTOR: Smith
DATE: 05/05/03

BEAM #	LOAD AT BREAK (lbs)	TABLE VALUE (lbs)	BREAK LOCATION (in)	WIDTH (in)	DEPTH (in)	FLEXURAL COEFFICIENT	FLEXURAL STRENGTH CPL (psi)	AGE AT BREAK (days)	TTF CH 1	TTF CH 2	AVERAGE TTF	BEAM TEMP (AVG)
	Enter	Enter	Enter	Enter	Enter			Enter	Enter	Enter		Enter
1	3000	3100	0.5	5.98	6.02	0.124586	386	24	650	650	650	26
2	3100	3250	0.5	6.00	6.01	0.124584	405	24	650	650	650	26
3	3050	3150	0.5	6.00	6.02	0.124171	391	24	650	650	650	26
4	3450	3400	0.5	5.98	6.00	0.125418	426	38	800	850	825	24
5	3550	3450	0.5	6.00	6.00	0.125000	431	38	800	850	825	24
6	3500	3425	0.5	6.00	6.00	0.125000	428	38	800	850	825	24
7	4000	4100	0.5	5.98	6.00	0.125418	514	55	1100	1150	1125	22
8	3990	4000	0.5	5.98	6.00	0.125418	502	55	1100	1150	1125	22
9	4000	4100	0.5	6.00	6.00	0.125000	513	55	1100	1150	1125	22
10	4600	4650	0.5	6.00	6.00	0.125000	581	72	1500	1500	1500	23
11	4700	4680	0.5	6.00	6.00	0.125000	585	72	1500	1500	1500	23
12	4750	4700	0.5	5.98	6.00	0.125418	589	72	1500	1500	1500	23

MIX INFORMATION	Enter
AIR:	7.2
SLUMP:	2
w/c:	0.41
MIX:	C-4WR-C15
FLY ASH SOURCE:	Port Neal #4
GGBFS SOURCE:	
CEMENT SOURCE:	Lehigh
COARSE AGGREGATE SOURCE:	Ames Mine
INTERM. AGGREGATE SOURCE:	
FINE AGGREGATE SOURCE:	Vandalia
WATER REDUCER BRAND:	Daratard 17
Add. Rate:	2 oz.
AIR ADMIXTURE BRAND:	Daravair 1400
Add. Rate:	6 oz.
METHOD OF DEVELOPMENT:	Maturity Meter
Desired Flexural Strength (MOR-CPL):	500 psi

REQUIRED TTF: **1066**



Certified Contractor Representative - ______________________
Signature

Maturity Curve Reviewed - ______________________
Testing Engineer

Comments:

cc: RCE, DME, Central Materials, Contractor

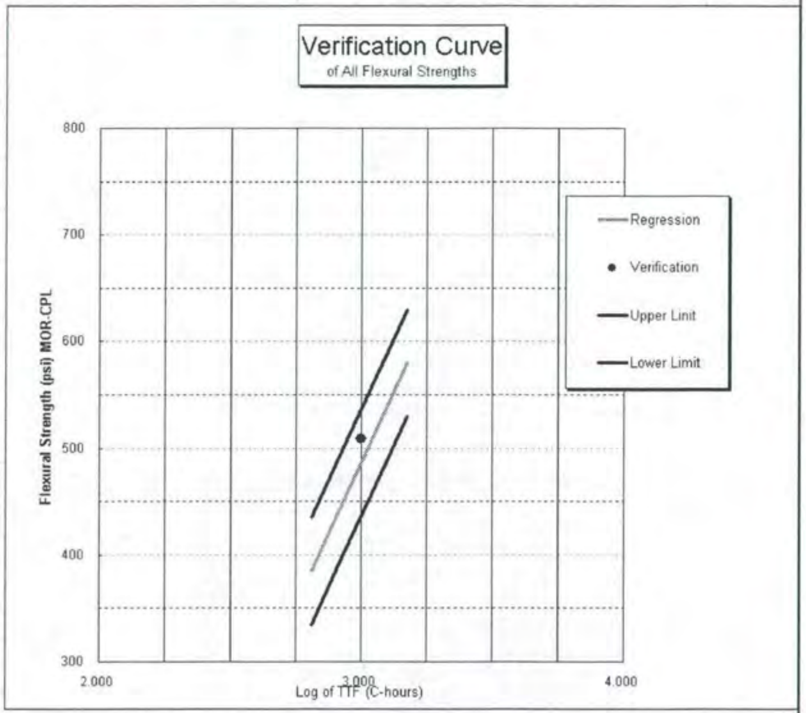
VERIFICATION OF MATURITY CURVE

CURVE #: 1
PROJ. #: IM-35-5(99)
MONITOR: Jenkins
CONTRACTOR: Manatt's
INSPECTOR: Smith
Verification DATE: 6/11/03

BEAM #	LOAD AT BREAK (lbs)	TABLE VALUE (lbs)	BREAK LOCATION (in)	WIDTH (in)	DEPTH (in)	FLEXURAL COEFFICIENT	FLEXURAL STRENGTH (psi)	AGE AT BREAK (DAYS)	TTF CH 1	TTF CH 2	AVERAGE TTF
	Enter	Enter	Enter	Enter	Enter			Enter	Enter	Enter	
1	4000	4100	0.5	6.00	6.00	0.125000	513	39	1000	1000	1000
2	3990	4000	0.5	6.00	6.00	0.125000	500	39	1000	1000	1000
3	4000	4100	0.5	6.00	6.00	0.125000	513	39	1000	1000	1000

AIR:	6.9	Enter
SLUMP:	2.5	Enter
w/c:	0.42	Enter
MIX:	C-4WR-C15	
FLY ASH:	Port Neal #4	
GGBFS:	0	
CEMENT:	Lehigh	
COARSE AGGREGATE:	Ames Mine	
INTERM. AGGREGATE:	0	
FINE AGGREGATE:	Vandalia	
WATER REDUCER:	Daratard 17	
Add. Rate:	2 oz.	
AIR ENTRAINER:	Daravair 1400	
Add. Rate:	6 oz.	
Method of Development:	Maturity Meter	
REQUIRED TTF:	**1066**	

P



CURVE VERIFICATION

TTF @ Break	1000
Beam 1 MOR (psi)	513
Beam 2 MOR (psi)	500
Beam 3 MOR (psi)	513
Beam Avg. MOR (psi)	508

Calculated psi @ TTF	485	**Range**		
		Minimum	435	***Curve Verification***
				OK
		Maximum	535	

Comments:

Verification strength above the upper limit does not require a new curve.

Certified Maturity Contractor Representative - ______________________
Signature

Maturity Curve Verification Reviewed - ______________________
Testing Engineer

cc: RCE, DME, Central Materials, Contractor

MATURITY.XLS
Jul-01

Procedure to Determine Datum Temperate Setting for Humboldt Maturity Meters

Key	Displays
Press **ENTER**	PRESENT VALUES CH 1 Temp: XX
Press **REC**	RECORDING 1. START
Press **REC**	SETUP 1. DATUM TEMP
Press **ENTER**	SETUP DATUM TEMP: -10

If datum temperature is not set to -10° C, press the up (↑) or down (↓) arrows to set the maturity meter to –10. Then press ENTER to save the settings.

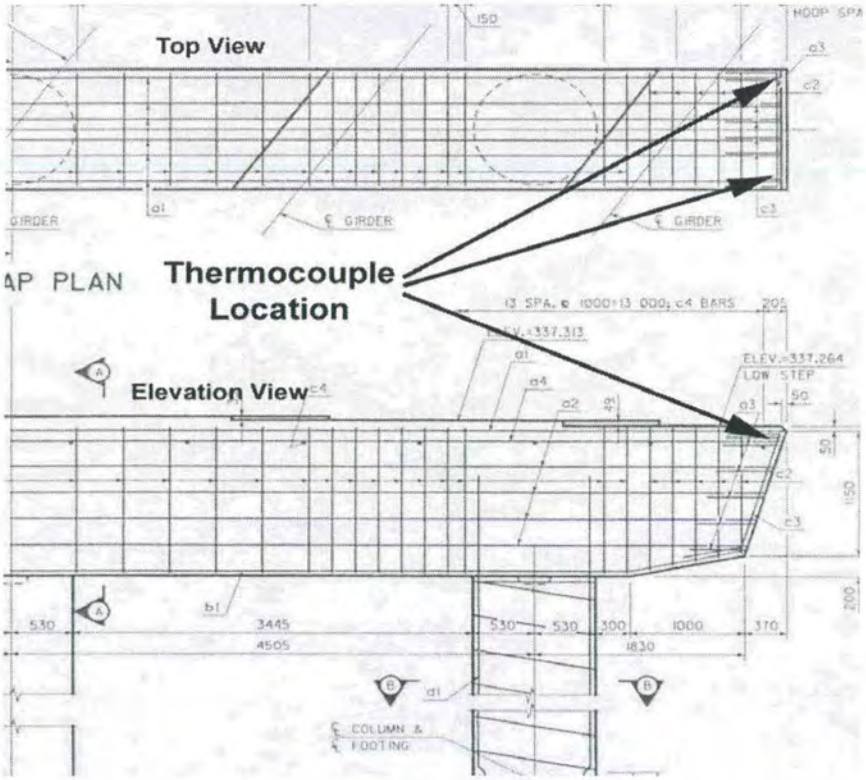


Figure 1. Typical thermocouple location placement in pier cap Use similar method for thermocouple placement in other structural elements.

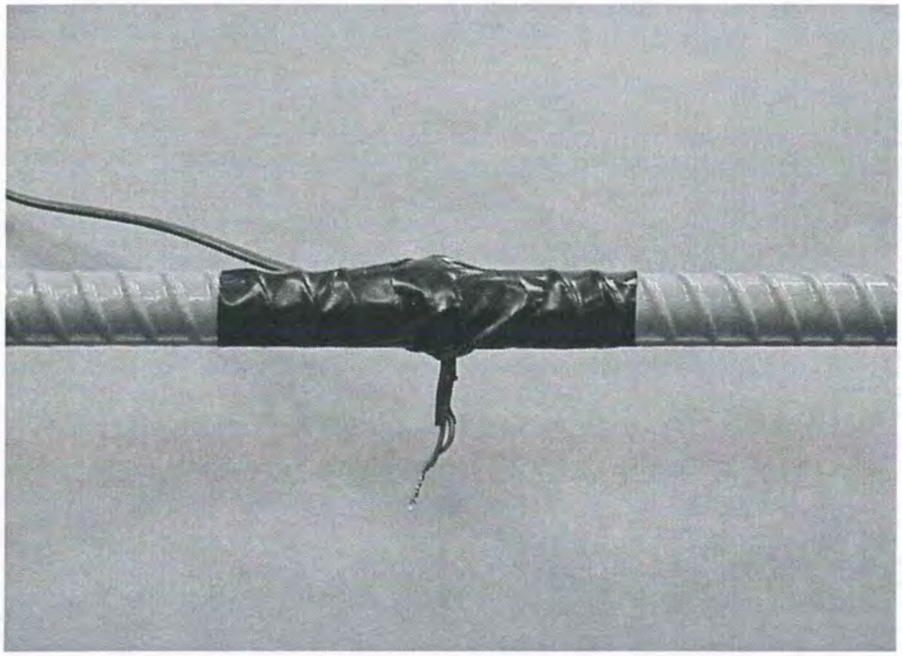


Figure 2. Typical attachment of thermocouple to reinforcing steel

April 17, 2007
Supersedes October 18, 2005

TEMPERATURE OF FRESHLY MIXED CONCRETE

SCOPE

This test method covers the determination of temperature of freshly mixed Portland Cement Concrete.

This standard may involve hazardous materials, operations, and equipment. This standard does not address all of the safety problems associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices.

SIGNIFICANCE & USE

This test method provides a means for measuring the temperature of freshly mixed concrete. It may be used to verify conformance to a specified requirement for temperature of concrete. For specification compliance, temperature shall be measured by means of an immersion temperature-measuring device. Infrared thermometers may be used for information purposes only.

PROCEDURE

A. Apparatus

1. Container. The container shall be made of nonabsorptive material and large enough to provide at least 3 in. (75 mm) of concrete in all directions around the sensor of the temperature-measuring device; the concrete cover shall also be at least three times the nominal maximum size of the coarse aggregate.

2. Temperature-measuring Device. The temperature-measuring device shall be capable of reading the temperature of the freshly mixed concrete to ±1°F (±0.5°C) throughout the entire temperature range likely to be encountered in the fresh concrete. Liquid-in-glass thermometers having a range of 0°F to 120°F (-18°C to 49°C) are satisfactory. Other thermometers of the required accuracy, including the metal immersion type, are acceptable.

3. Thermometer Marking. Partial-immersion liquid-in-glass thermometers (and possibly other types) shall have a permanent mark to which the device must be immersed without applying a correction factor.

4. Reference Temperature-measuring Device. The reference temperature-measuring device shall be a liquid-in-glass thermometer readable to 0.5°F (0.2°C) that has been verified and calibrated. The calibration certificate or report indicating conformance to ASTM E77 requirements shall be available for inspection.

B. Calibration of Temperature-measuring Device

1. Each temperature-measuring device used for determining the temperature of freshly mixed concrete shall be calibrated before initial use, or whenever there is a question of accuracy. This calibration shall be performed by comparing the readings on the temperature-measuring device at two temperatures at least 27°F (15°C) apart.

C. Sampling Concrete

1. The temperature of freshly mixed concrete may be measured in the transporting equipment providing the sensor of the temperature-measuring device has at least 3 in. (75 mm) of concrete cover in all directions around it.

2. If the transporting equipment is not used as the container, a sample shall be prepared as follows:

   a. Immediately prior to sampling the freshly mixed concrete, dampen (with water) the sample container.

   b. Sample the freshly mixed concrete in accordance with IM 327.

   c. Place the freshly mixed concrete into the container. (**NOTE:** When concrete contains a nominal maximum size of aggregate greater than 3 in. (75 mm), it may require 20 minutes after mixing before the temperature is stabilized.)

   d. Complete the temperature measurement of the freshly mixed concrete within five minutes after obtaining the sample.

D. Test Procedure

1. Place the temperature-measuring device in the freshly mixed concrete, so the temperature-sensing portion is submerged in a minimum of 3 in. (75 mm) of concrete. Gently press the concrete around the temperature-measuring device at the surface of the concrete so the ambient air temperature does not affect the reading.

2. Leave the temperature-measuring device in the freshly mixed concrete for a minimum period of two minutes or until the temperature reading stabilizes, then read and record the temperature.

3. Complete the temperature measurement of the freshly mixed concrete within five minutes of obtaining the sample.

4. Record the measured temperature of the freshly mixed concrete to the nearest 1°F (0.5°C).

Iowa Department of Transportation

Office of Materials

October 16, 2007
Supersedes April 17, 2007

Matls. IM 401

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

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

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.

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.

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.

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 l 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.

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. Percent Alkali Equivalent

The percent alkali equivalent listed in Appendix A shall be used in calculating the alkali level of the cementitious materials which may affect proportions for concrete mixtures on construction projects, when limitations are specified. Any adjustments in mixture proportions shall be the responsibility of the contractor and approved by the engineer.

K. 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.

L. 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.

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.

APPROVED SOURCES
PORTLAND & BLENDED CEMENTS

The plant and terminal sources listed below are approved to furnish Type III Cement and other types of cement listed below on the basis of certification. A specific gravity of 3.17 should be used for Type III Cements.

REGULAR SUPPLIERS

SOURCE	PLANT	TYPE	SP GR	CODE	APPROVED TERMINALS, NOTE 1
Ash Grove Cement	Louisville, NE	I/II	3.14	PC0002	Louisville, NE; Des Moines, IA; Hawarden, IA
		IP (25)	2.95	PC0008	
Continental Cement Co.	Hannibal, MO	I	3.14	PC0201	Bettendorf, IA; Hannibal, MO
		II	3.14	PC0202	
Holcim, Inc.	Mason City, IA	I	3.14	PC0301	Mason City, IA; Des Moines, IA; Cedar Rapids, IA
		IS (25)	3.09	PC0307	LaCrosse, WI; Rock Island, IL
Lafarge N. America	Buffalo, IA	I/II	3.14	PC0502	W. Des Moines, IA; Buffalo, IA; Winona, MN
		IS (20)	3.10	PC0507	
Lehigh Cement Co.	Mason City, IA	I	3.14	PC0401	Mason City, IA
		II	3.14	PC0402	
Monarch Cement Co.	Humboldt, KS	I/II	3.14	PC0802	W. Des Moines, IA

INTERMITTENT SUPPLIERS

SOURCE	PLANT	TYPE	SP GR	CODE	APPROVED TERMINALS, NOTE 1
Ash Grove Cement	Chanute, KS	I/II	3.14	PC0102	Des Moines, IA
St. Mary's Cement (Canada)	St. Mary's, Ontario	II	3.14	PC1702	
Buzzi Unicem	Pryor, OK	I	3.14	PC1401	Bonner Springs, KS
	Cape Girardeau, MO	I/II	3.14	PC1502	
GCC Dacotah	Rapid City, SD	I/II	3.14	PC1002	Sioux Falls, SD
Hercules General/ Holcim, Inc.	Milaki, Greece	I	3.14	PC1201	LaCrosse, WI
Holcim, Inc.	Siam, Thailand	I/II	3.14	PC1602	LaCrosse, WI; Fremont, NE; Des Moines, IA
	Ssangyong, S. Korea	I/II	3.14	PC2102	Summit, IL; Lemont, IL
	Clarksville, MO	I	3.14	PC0901	
		IS (25)	3.09	PC0907	
	Three Forks, MT	I/II	3.14	PC1102	
	Portland, CO	I/II	3.14	PC2002	
	Ada, OK	I	3.14	PC1901	
	Lima, Peru	I	3.14	PC2601	
	Jidong, China	I/II	3.14	PC2702	
Lafarge N. America	Alpena, MI	I	3.14	PC1801	W. Des Moines, IA; Omaha, NE
	Waukegan, IL	I	3.14	PC2301	
	Sugar Creek, Mo	I/II	3.14	PC0702	
	Fredonia, KS	I/II	3.14	PC0602	
	Exshaw, Alberta	I/II	3.14	PC1302	
	Grand Chain, IL	Tercem 3000	3.07	PC2509	
Lehigh Cement Co.	Canakkale, Turkey	I/II	3.14	PC2402	

NOTE 1: Each terminal can be used to finish all approved types of cements from the same producer.

CHEMICAL ADMIXTURES FOR CONCRETE

GENERAL

Air entraining, water reducing and retarding, and water-reducing admixtures for Portland Cement Concrete shall meet the requirements of applicable Iowa Department of Transportation Specifications.

ACCEPTANCE

Acceptance of air entraining, water reducing and retarding, and water-reducing admixtures for use on Iowa Department of Transportation projects will be on the basis of manufacturer and brand name approval.

Approved manufacturers and brand names for the four different types of admixtures are listed in Appendixes A, B, C, D, E and F.

For all types of admixtures, the source, brand name, and lot/batch number must be identifiable by markings on the container and by description on the invoice. The manufacturer and supplier shall maintain a record of shipment, which identifies the brand, lot/batch number and certified test data for each shipment. This data shall be made available to the contracting authority when requested.

Material suspected of being frozen shall be sampled and tested prior to use. Material older than 18 months shall be sampled and tested prior to use.

MANUFACTURER, BRAND NAME APPROVAL, USAGE GUIDELINES

To obtain approval for any admixture type, the manufacturer shall submit the following items to the Office of Materials in Ames:

1. Product identification including brand name and product number
2. Complete manufacturer's recommendation for usage
3. Independent test data on admixture showing compliance with appropriate ASTM specification
4. A current Materials Safety Data Sheet (MSDS)
5. A one-quart (one-liter) representative sample

Specific requirements and testing procedures for each type of admixture are as follows:

A. Air Entraining Admixtures

Air entraining admixtures shall meet the requirements of Iowa Department of Transportation Standard Specifications Section 4103 and ASTM C260.

When an air-entraining admixture is produced by neutralizing vinsol resin with sodium hydroxide, the manufacturer shall submit to the Central Office a certification concerning the admixture in the following form:

> "This is to certify that the product (trade name), as manufactured and sold by the (company), is an aqueous solution of vinsol resin that has been neutralized with sodium hydroxide. The ratio of sodium hydroxide to vinsol resin is one part of sodium hydroxide to (number) parts of vinsol resin. The normal percentage of solids based on the residue dried at 105EC for 3 hours is (number). This percentage will be controlled within minus 1.0 and plus 3.0 of this figure. No other additive or chemical agent is present in this solution."

Brand name approval of air entraining admixtures does not preclude material rejection if satisfactory entrainment air content results in the plastic concrete are not readily and consistently achieved.

Approved brands of air entraining admixtures are listed in Appendix A of this IM.

B. Water-Reducing & Retarding Admixtures

These admixtures can be used to retard structural concrete in bridge floors and for water reduction, retardation, or water reduction and retardation in concrete pavement.

When they are used in bridge floors, use the dosage rates shown in Appendix B, for retarding structural concrete. Use the dosage rate shown for the respective concrete temperature.

When they are used in concrete pavement, use the dosage in Appendix B, for use in concrete pavement. Use the single dosage rate shown for water reduction, retardation, or water reduction and retardation. Dosage rates may be adjusted in accordance with the manufacturer's recommendation during cooler conditions to prevent overextending setting times.

Water-reducing and retarding admixtures shall meet the requirements of ASTM C494; Type D and those outlined herein.

In addition to meeting requirements of ASTM C494, Type D, tests may also be required to show strength and retardation performance as described in this Section B and strength and water reduction performance as described in Section C of this IM.

The analysis as a retarder utilizes concrete specimens from two D-57 mixtures. One mix shall contain the retarding admixture, and the other shall be a control without the retarder. The results of the concrete with retarder as compared to the control shall show:

A minimum increase of 10% in the 7-day compressive strength; a minimum increase of 33% in setting time; reduction in water requirements.

When use as a retarder is specified or authorized by the engineer, the contractor shall be responsible for its use and application of the proper dosage rate. When using retarding admixtures, it may be necessary to adjust the quantity of air entraining agent. When fly ash is used in the concrete, the dosage rate shall be applied to both the cement and fly ash combined.

Approved brands of water-reducing and retarding admixtures are listed in Appendix B of this IM. Recommended dosage is given for use in concrete pavement. Appendix B also contains a guideline for dosage rates and working time limits for use in structural concrete based on an estimated maximum temperature of the concrete during placement at the point of discharge. Working time limits have been determined by AASHTO T197 using 200 psi (1.38 MPa) penetration resistance.

C. Water-Reducing Admixtures (WR)

Water-reducing admixtures shall meet the requirements of ASTM C494, Type A, and those outlined herein.

Concrete specimens shall be made from two C-3 mixtures. One mix shall contain the WR admixture with an 8% reduction in cement mass and the other shall be a control with no cement reduction or WR admixture. Compressive strengths of WR mix must equal or exceed that of the control at 28 days. Water-reducing admixtures shall also be tested with a deck mix as per ASTM C494. When fly ash is used in the concrete, the dosage rate shall be applied to both the cement and fly ash weight combined.

Approved brands of water-reducing admixtures with their proper dosage rates are listed in Appendix C of this IM.

D. High Range Water-Reducing Admixtures (HRWR, sometimes called super water-reducer)

High Range water-reducing admixtures shall meet the requirements of ASTM C494; Type F and those outlined herein. Concrete specimens shall be made from two basic prestressed mixtures 705 lb. cement/yd^3 (419 kg cement/m^3). One mix shall contain the super water-reducing admixture and the other shall be a control mix with no HRWR admixture. There shall be no cement reduction in either mix. Compressive strengths of the HRWR mix must exceed that of the control at 1, 3, and 28 days. When fly ash is used in the concrete, the dosage rate shall be applied to both the cement and fly ash combined.

Approved brands of high range water-reducing admixtures with their recommended dosage rates are listed in Appendix D of this IM.

E. Non-Chloride Accelerating (NCA) Admixtures

Non-Chloride Accelerating Admixtures shall meet the requirements of ASTM C494, Type C or E, and those outlined herein. Total chloride content, which may come from some indirect sources, shall not exceed 0.1% in the admixtures.

Concrete specimens shall be made from two C-3 mixtures. One mix shall contain the NCA admixture and the other shall be a control with no NCA admixture. Compared to the control mix the NCA mix must achieve a minimum decrease of 33% in initial setting time, a minimum increase of 25% in 3-day compressive strength, and equal or greater in 28-day compressive strength.

Approved brands of Non-Chloride Accelerating Admixtures with their recommended dosage rates are listed in Appendix E of this IM.

F. Admixtures for Prestressed & Precast Concrete

These admixtures are used for dry-cast concrete. Benefits of these admixtures include increasing production rate, improvement of visual appeal, greater strength, more durable, better compactability, and extension of life of molds and machines parts. In order to get an admixture approval, its producer shall prove that the use of the admixture will not reduce strength of concrete, and provide evidence of the above-mentioned benefits.

Approved brands of admixtures for prestressed and precast concrete with their recommended dosage rates are listed in Appendix F of this IM.

If alternative requirements specified in ASTM C 494 are met, an admixture may be provisionally approved based on six-month test results. Producer shall submit one-year test results from an independent laboratory for final approval as soon as they become available. The failure or delay in submitting one-year results may lead to revoking of provisional approval.

Satisfactory evaluation reports by the National Transportation Product Evaluation Program (NTPEP) will be accepted for approval.

Approval of admixtures may be withdrawn because of deficient test results; product changes made after original approval, or unsatisfactory field performance.

AGITATION OF ADMIXTURES

Provision shall be made to stir, agitate, or circulate air-entraining admixtures prior to use so as to ensure a uniform and homogeneous mixture of solids and solution. It is the admixture supplier's responsibility to the contractor to provide a quality product. Therefore the admixture suppliers shall be responsible for the system used to maintain the quality product described above.

Retarding, water-reducing, and super water-reducing admixtures shall be stirred, circulated, or agitated thoroughly once a day prior to operation of the proportioning plant to maintain the solids in suspension. The agitating shall be done in such a way that the solution in the holding or storage tank is circulated for a minimum of five minutes each day per 100 gallons (380 liters) of solution or any fraction thereof. A circulating pump with a 250-watt (1/3 hp) pump motor and a 5/8-inch (16 mm) inside diameter hose will be considered as a minimum requirement. The engineer shall approve the method of agitation. **NOTE:** Introducing air into a tank will not be acceptable.

CERTIFICATION

A. FOR MANUFACTURER

At the beginning of each calendar year, a certification form will be sent to each manufacturer. If the admixture to be supplied during that year is identical with the formulation previously tested and approved, then the manufacturer shall complete the quality control limits to be followed and return it to the Office of Materials in Ames, Iowa.

B. FOR DISTRIBUTOR

At the beginning of each calendar year, a certification form will be sent to each distributor. The distributor shall certify that admixtures to be supplied are not altered and will be distributed as received from the manufacturer.

MONITOR SAMPLING & TESTING

Monitor samples will be obtained and sent to Central Materials for testing. Sampling frequency shall be according to IM 204. The sample size shall be one 1 pint (0.5 liter).

For all admixtures, only one acceptance sample per lot/batch is necessary. No project assurance samples are needed.

Samples will be tested for variation from the manufacturer target for solids, specific gravity and chloride content.

APPROVED SOURCES
AIR-ENTRAINING ADMIXTURES

VINSOL RESIN BRAND NAME	PRODUCER/DISTRIBUTOR	LOCATION
Catexol AE260 Catexol AE360	Amix Concrete Tech.	Middlebranch, OH
Daravair - 1400 Darex II AEA Darex EH AEA	W.R. Grace & Company	Boston, MA
Euco Air Mix	Euclid Chemical Distributed by Brett Admixtures	Cleveland, OH Des Moines, IA
MB AE 90 MB-VR Standard Micro-Air Pave-Air Pave-Air 90	BASF Admixtures, Inc.	Cleveland, OH
Polychem VR	General Resource Technology	Eagen, MN
RVR-15	RussTech, Inc.	Louisville, KY
Sika AER	Sika Corporation Dist. by Contractors Steel Corp.	Marion, OH Des Moines, IA

NON-VINSOL RESIN BRAND NAME	PRODUCER/DISTRIBUTOR	LOCATION
AEA-92 AEA-92S	Euclid Chemical Company Distributed by Brett Admixtures	Cleveland, OH
Daravair 1000 Daravair AT30 Daravair AT60	W.R. Grace & Company	Boston, MA
Everair Plus	BASF Admixtures, Inc.	Cleveland, OH
EXP 960 KAJ	W.R. Grace & Company	Boston, MA
Polychem AE	General Resource Technology	Eagen, MN
RSA-10	RussTech, Inc.	Louisville, KY
Sika AEA-15 Sika Air	Sika Corporation	Marion, OH
Super Air Plus* Air Plus*	Fritz-Pak Corporation	Dallas, TX

*Dry powdered admixture, prepackaged in water-soluble bag.

APPROVED SOURCES
WATER REDUCING & RETARDING ADMIXTURES & GUIDELINES

FOR USE IN STRUCTURAL CONCRETE: RETARDING ADMIXTURES
GUIDELINES FOR DOSAGE RATES WITH ANTICIPATED WORKING TIME LIMITS

1. Dosage is in fluid ounces per 100 lbs. (mL/kg) of cement, fly ash, and ggbfs.
2. Check percent of air as retarding admixtures tend to increase air contents

Working time limits for various cements with -NO RETARDER

Mix Temp at point of discharge		Dosage	Type I/II, no fly ash	Type I/II with fly ash	Type I(SM), IP with fly ash	Type IS with fly ash
°F	°C	fl. oz. (ml/kg)	hours	hours	hours	hours
55	13	0	3.8	4.8	5.8	7.8
65	18	0	3.1	3.8	4.6	6.1
75	24	0	2.5	3.0	3.5	4.5
85	29	0	2.2	2.5	2.7	3.2
95	35	0	1.9	1.9	1.9	1.9

Working time limits for various cements with - LC 500R

Mix Temp at point of discharge		Dosage	Type I/II, no fly ash	Type I/II with fly ash	Type I(SM), IP with fly ash	Type IS with fly ash
°F	°C	fl. oz. (ml/kg)	hours	Hours	Hours	hours
55	13	2 (1.3)				
		3 (2.0)				
		4 (2.6)				
		5 (3.3)				
65	18	3 (2.0)	9.1	9.8	10.6	12.1
		4 (2.6)	10.2	11.0	11.7	13.2
		5 (3.3)	11.4	12.1	12.9	14.4
		6 (3.9)	13.2	13.9	14.7	16.2
75	24	3 (2.0)	6.2	6.7	7.2	8.2
		4 (2.6)	7.9	8.4	8.9	9.9
		5 (3.3)	9.4	9.9	10.4	11.4
		6 (3.9)				
		7 (4.6)				
85	29	3 (2.0)	5.5	5.8	6.0	6.5
		4 (2.6)	6.1	6.4	6.6	7.1
		5 (3.3)	8.2	8.5	8.7	9.2
		6 (3.9)				
		7 (4.6)				
95	35	3 (2.0)	4.7	4.7	4.7	4.7
		4 (2.6)	6.2	6.2	6.2	6.2
		5 (3.3)	7.6	7.6	7.6	7.6
		6 (3.9)	8.1	8.1	8.1	8.1
		7 (4.6)				
		8 (5.2)				

Working time limits for various cements with - Plastocrete 161-MR

Mix Temp at point of discharge		Dosage	Type I/II, no fly ash	Type I/II with fly ash	Type I(SM), IP with fly ash	Type IS with fly ash
°F	°C	fl. oz. (ml/kg)	hours	hours	hours	hours
55	13	2 (1.3)				
		3 (2.0)				
		4 (2.6)				
		5 (3.3)				
65	18	3 (2.0)	4.9	5.6	6.4	7.9
		4 (2.6)	6.8	7.5	8.3	9.8
		5 (3.3)	10.9	11.6	12.4	13.9
		6 (3.9)	19.3	20.0	20.8	22.3
75	24	3 (2.0)	3.4	3.9	4.4	5.4
		4 (2.6)	4.5	5.0	5.5	6.5
		5 (3.3)	6.6	7.1	7.6	8.6
		6 (3.9)	10.5	11.0	11.5	12.5
		7 (4.6)	18.0	18.5	19.0	20.0
85	29	3 (2.0)	2.8	3.1	3.3	3.8
		4 (2.6)	3.5	3.8	4.0	4.5
		5 (3.3)	4.6	4.9	5.1	5.6
		6 (3.9)	6.5	6.8	7.0	7.5
		7 (4.6)	9.9	10.2	10.4	10.9
95	35	3 (2.0)	2.1	2.1	2.1	2.1
		4 (2.6)	2.6	2.6	2.6	2.6
		5 (3.3)	3.3	3.3	3.3	3.3
		6 (3.9)	4.6	4.6	4.6	4.6
		7 (4.6)	7.0	7.0	7.0	7.0
		8 (5.2)	11.6	11.6	11.6	11.6

Working time limits for various cements with – Plastiment 100

Mix Temp at point of discharge		Dosage	Type I/II, no fly ash	Type I/II with fly ash	Type I(SM), IP with fly ash	Type IS with fly ash
°F	°C	fl. oz. (ml/kg)	hours	hours	hours	hours
55	13	2 (1.3)				
		3 (2.0)				
		4 (2.6)				
		5 (3.3)				
65	18	3 (2.0)	5.5	6.2	7.0	8.5
		4 (2.6)	7.6	8.3	9.1	10.6
		5 (3.3)	12.1	12.8	13.6	15.1
		6 (3.9)	21.5	22.2	23.0	24.5
75	24	3 (2.0)	3.8	4.3	4.8	5.8
		4 (2.6)	5.0	5.5	6.0	7.0
		5 (3.3)	7.4	7.9	8.4	9.4
		6 (3.9)	11.7	12.2	12.7	13.7
		7 (4.6)	20.1	20.6	21.1	22.1
85	29	3 (2.0)	3.2	3.5	3.7	4.2
		4 (2.6)	3.9	4.2	4.4	4.9
		5 (3.3)	5.2	5.5	5.7	6.2
		6 (3.9)	7.3	7.6	7.8	8.3
		7 (4.6)	10.9	11.2	11.4	11.9
95	35	3 (2.0)	2.4	2.4	2.4	2.4
		4 (2.6)	2.9	2.9	2.9	2.9
		5 (3.3)	3.7	3.7	3.7	3.7
		6 (3.9)	5.2	5.2	5.2	5.2
		7 (4.6)	7.9	7.9	7.9	7.9
		8 (5.2)	12.9	12.9	12.9	12.9

Working time limits for various cements with – Pozzolith 100XR

Mix Temp at point of discharge		Dosage	Type I/II, no fly ash	Type I/II with fly ash	Type I(SM), IP with fly ash	Type IS with fly ash
°F	°C	fl. oz. (ml/kg)	hours	hours	hours	hours
55	13	2 (1.3)				
		3 (2.0)				
		4 (2.6)				
		5 (3.3)				
65	18	3 (2.0)	9.0	9.7	10.5	12.0
		4 (2.6)				
		5 (3.3)				
		6 (3.9)				
75	24	3 (2.0)	6.1	6.6	7.1	8.1
		4 (2.6)	7.8	8.3	8.8	9.8
		5 (3.3)	9.2	9.7	10.2	11.2
		6 (3.9)				
		7 (4.6)				
85	29	3 (2.0)	5.2	5.5	5.7	6.2
		4 (2.6)	6.7	7.0	7.2	7.7
		5 (3.3)	8.1	8.4	8.6	9.1
		6 (3.9)				
		7 (4.6)				
95	35	3 (2.0)	4.5	4.5	4.5	4.5
		4 (2.6)	6.0	6.0	6.0	6.0
		5 (3.3)	7.4	7.4	7.4	7.4
		6 (3.9)				
		7 (4.6)				
		8 (5.2)				

Working time limits for various cements with – Daratard 17

Mix Temp at point of discharge		Dosage	Type I/II, no fly ash	Type I/II with fly ash	Type I(SM), IP with fly ash	Type IS with fly ash
°F	°C	fl. oz. (ml/kg)	hours	hours	hours	hours
55	13	2 (1.3)				
		3 (2.0)				
		4 (2.6)				
		5 (3.3)				
65	18	3 (2.0)				
		4 (2.6)				
		5 (3.3)				
		6 (3.9)				
75	24	3 (2.0)	4.3	4.7	5.3	6.3
		4 (2.6)	6.6	7.1	7.6	8.6
		5 (3.3)	7.6	8.1	8.6	9.6
		6 (3.9)				
		7 (4.6)				
85	29	3 (2.0)	4.3	4.6	4.8	5.3
		4 (2.6)	5.2	5.5	5.7	6.2
		5 (3.3)	6.5	6.8	7.0	7.5
		6 (3.9)				
		7 (4.6)				
95	35	3 (2.0)	3.9	3.9	3.9	3.9
		4 (2.6)	4.4	4.4	4.4	4.4
		5 (3.3)	5.7	5.7	5.7	5.7
		6 (3.9)				
		7 (4.6)				
		8 (5.2)				

Working time limits for various cements with – Eucon Retarder 100

Mix Temp at point of discharge		Dosage	Type I/II, no fly ash	Type I/II with fly ash	Type I(SM), IP with fly ash	Type IS with fly ash
°F	°C	fl. oz. (ml/kg)	hours	hours	hours	hours
55	13	2 (1.3)				
		3 (2.0)	9.6	10.6	11.6	13.6
		4 (2.6)	10.4	11.4	12.4	14.4
		5 (3.3)	12.3	13.3	15.3	16.3
65	18	3 (2.0)	8.2	8.9	9.7	11.2
		4 (2.6)	10.0	10.7	11.5	13.0
		5 (3.3)	11.7	12.4	13.2	14.7
		6 (3.9)	12.9	13.6	14.4	15.9
75	24	3 (2.0)	7.5	8.0	8.5	9.5
		4 (2.6)	9.9	10.4	10.9	11.9
		5 (3.3)	11.9	12.4	12.9	13.9
		6 (3.9)	12.5	13.0	13.5	14.5
		7 (4.6)				
85	29	3 (2.0)	6.8	7.1	7.3	7.8
		4 (2.6)	9.6	9.9	10.1	10.6
		5 (3.3)	11.9	12.2	12.4	12.9
		6 (3.9)	11.9	12.2	12.4	12.9
		7 (4.6)				
95	35	3 (2.0)	6.8	6.8	6.8	6.8
		4 (2.6)	9.9	9.9	9.9	9.9
		5 (3.3)	11.8	11.8	11.8	11.8
		6 (3.9)	11.8	11.8	11.8	11.8
		7 (4.6)				
		8 (5.2)				

Working time limits for various cements with – Catexol 1000R

Mix Temp at point of discharge		Dosage	Type I/II, no fly ash	Type I/II with fly ash	Type I(SM), IP with fly ash	Type IS with fly ash
°F	°C	fl. oz. (ml/kg)	hours	hours	hours	hours
55	13	2 (1.3)	4.5	5.5	6.5	8.5
		3 (2.0)	5.5	6.5	7.5	9.5
		4 (2.6)	7.0	8.0	9.0	11.0
		5 (3.3)				
65	18	3 (2.0)	4.8	5.5	6.3	7.8
		4 (2.6)	5.6	6.3	7.1	8.6
		5 (3.3)	6.8	7.5	8.3	9.8
		6 (3.9)				
75	24	3 (2.0)	5.2	5.7	6.2	7.2
		4 (2.6)	5.7	6.2	6.7	7.7
		5 (3.3)	6.7	7.2	7.7	8.7
		6 (3.9)				
		7 (4.6)				
85	29	3 (2.0)	4.8	5.1	5.3	5.8
		4 (2.6)	5.4	5.7	5.9	6.4
		5 (3.3)	6.2	6.5	6.7	7.2
		6 (3.9)				
		7 (4.6)				
95	35	3 (2.0)	4.5	4.5	4.5	4.5
		4 (2.6)	5.1	5.1	5.1	5.1
		5 (3.3)	5.7	5.7	5.7	5.7
		6 (3.9)	6.5	6.5	6.5	6.5
		7 (4.6)				
		8 (5.2)				

Working time limits for various cements with – FR-IL

Mix Temp at point of discharge		Dosage	Type I/II, no fly ash	Type I/II with fly ash	Type I(SM), IP with fly ash	Type IS with fly ash
°F	°C	fl. oz. (ml/kg)	hours	hours	hours	hours
55	13	2 (1.3)				
		3 (2.0)				
		4 (2.6)				
		5 (3.3)				
65	18	3 (2.0)				
		4 (2.6)				
		5 (3.3)				
		6 (3.9)				
75	24	3 (2.0)	4.4	4.9	5.4	6.4
		4 (2.6)	4.6	5.1	5.6	6.6
		5 (3.3)	4.8	5.3	5.8	6.8
		6 (3.9)	5.7	6.0	6.7	7.7
		7 (4.6)				
85	29	3 (2.0)	3.4	3.7	3.9	4.4
		4 (2.6)	3.6	3.9	4.1	4.6
		5 (3.3)	3.8	4.1	4.3	4.8
		6 (3.9)	4.0	4.3	4.5	5.0
		7 (4.6)				
95	35	3 (2.0)				
		4 (2.6)				
		5 (3.3)				
		6 (3.9)				
		7 (4.6)				
		8 (5.2)				

Working time limits for various cements with – Pozzolith 300R

Mix Temp at point of discharge		Dosage	Type I/II, no fly ash	Type I/II with fly ash	Type I(SM), IP with fly ash	Type IS with fly ash
°F	°C	fl. oz. (ml/kg)	hours	hours	hours	hours
55	13	2 (1.3)	4.5	5.5	5.5	8.5
		3 (2.0)	5.3	6.3	6.3	9.3
		4 (2.6)	6.8	7.8	8.8	10.8
		5 (3.3)				
65	18	3 (2.0)	4.6	5.3	6.1	7.6
		4 (2.6)	5.5	6.2	7.0	8.5
		5 (3.3)	6.8	7.5	8.3	9.8
		6 (3.9)				
75	24	3 (2.0)	4.7	5.2	5.7	6.7
		4 (2.6)	6.0	6.5	7.0	8.0
		5 (3.3)	7.2	7.7	8.2	9.2
		6 (3.9)				
		7 (4.6)				
85	29	3 (2.0)	4.6	4.9	5.1	5.6
		4 (2.6)	5.3	5.6	5.8	6.3
		5 (3.3)	6.4	6.7	6.9	7.4
		6 (3.9)				
		7 (4.6)				
95	35	3 (2.0)	4.1	4.1	4.1	4.1
		4 (2.6)	4.7	4.7	4.7	4.7
		5 (3.3)	5.6	5.6	5.6	5.6
		6 (3.9)	6.6	6.6	6.6	6.6
		7 (4.6)				
		8 (5.2)				

APPROVED SOURCES
WATER REDUCING & RETARDING ADMIXTURES

FOR USE IN CONCRETE PAVEMENTS:

NOTE: Mixed-to-placed time period may be extended as per Iowa DOT Standard Specifications Section 2301.13.D.

Brand Name	**Producer/Distributor**	**Recommended Minimum Dosage**	
		Kg/mL cementitious materials	100 lb./fl. oz. cementitious materials
Catexol 800 R	AXIM Concrete Technologies	2.0	3
Catexol 1000R	AXIM Concrete Technologies	2.0	3
Daratard 17	W.R. Grace & Company	2.0	3
Daratard HC	W.R. Grace & Company	2.0	3
Delvo Stabilizer	Degussa Admixtures, Inc.	2.6	4
Eucon Retarder 100	Euclid Chemical Company Distributed by Brett Admixtures	1.3	2
LC-500R	RussTech	2.0	3
Plastiment	Sika Corporation	1.3	2
Plastiment 100	Sika Corporation	2.0	3
Plastocrete 161	Sika Corporation	1.3	2
Plastocrete 161 M R	Sika Corporation	2.0	3
Pozzolith 100 X R	Degussa Admixtures, Inc.	2.0	3
Pozzolith 200N	Degussa Admixtures, Inc.	2.0	3
Pozzolith 300R	Degussa Admixtures, Inc.	2.0	3
Polychem R	General Resource Technology	2.0	3
Recover	W.R. Grace & Company	See Manufacturer's Recommendations	

Brand Name (Con't) Dosage	**Producer/Distributor**	**Recommended**	**Minimum**
		Kg/mL cementitious materials	100 lb./fl. oz. cementitious materials
Standard Delayed Set	Fritz-Pak Corporation	2.6	4*
WRDA with Hycol	W.R. Grace & Company	2.0	3

*Dry powdered admixture, pre-packaged in water-soluble bag.

APPROVED SOURCES
WATER REDUCING ADMIXTURES

CONCRETE PAVEMENT

		RECOMMENDED MIN. DOSAGE	
BRAND NAME	PRODUCER/DISTRIBUTOR	mL/kg cementitious materials	fl. oz./100 lb. cementitious materials
	Regular Water Reducers		
#1920 Auger Aid	SPECCO Industries	5.2	8.0
Catexol 800 N	AXIM Concrete Technologies	2.0	3.0
Catexol 1000N	AXIM Concrete Technologies	1.3	2.0
Eucon WR	Euclid Chemical Company Distributed by Brett Admixtures	2.6	4.0
Eucon WR-75	Euclid Chemical Company Distributed by Brett Admixtures	2.0	3.0
Eucon WR-91	Euclid Chemical Company Distributed by Brett Admixtures	2.0	3.0
FinishEase NC	RussTech, Inc.	3.3	5.0
Glenium 3000 NS	BASF Admixtures, Inc.	2.6	4.0
Glenium 3030 NS	BASF Admixtures, Inc.	3.9	6.0
Glenium 3200 HES	BASF Admixtures, Inc.	1.3	2.0
LC-400	RussTech, Inc.	2.6	4.0
LC-400P	RussTech, Inc.	3.3	5.0
LC-500R	RussTech, Inc.	2.0	3.0
Master Pave	BASF Admixtures, Inc.	3.3	5.0
Master Pave$^+$	BASF Admixtures, Inc.	2.6	4.0
Master Pave N	BASF Admixtures, Inc.	1.3	2.0

CONCRETE PAVEMENT (Continued)

		RECOMMENDED MIN. DOSAGE	
BRAND NAME	PRODUCER/DISTRIBUTOR	mL/kg cementitious materials	fl. oz./100 lb. cementitious materials
Regular Water Reducers (Continued)			
Master Pave RI	BASF Admixtures, Inc.	1.3	2.0
Plastocrete 161	Sika Corporation Dist. by Contractors Steel Corp.	2.0	3.0
Plastocrete 169	Sika Corporation	2.6	4.0
Polychem 1000	General Resource Tech.	2.0	3.0
Polychem 400 NC	General Resource Tech.	2.0	3.0
Polychem KB-1000	General Resource Tech.	2.0	3.0
Pozzolith 200N	BASF Admixtures, Inc.	2.0	3.0
Pozzolith 220N	BASF Admixtures, Inc.	2.0	3.0
Pozzolith 322 N	BASF Admixtures, Inc.	1.6	2.5
PS 1466	BASF Admixtures, Inc.	1.3	2.0
Sikament 686	Sika Corporation	2.0	3.0
WRDA-82	W.R. Grace & Company	2.3	3.5
WRDA with Hycol	W.R. Grace & Company	2.0	3.0

CONCRETE PAVEMENT (Continued)

BRAND NAME	PRODUCER/DISTRIBUTOR	RECOMMENDED MIN. DOSAGE mL/kg cementitious materials	RECOMMENDED MIN. DOSAGE fl. oz./100 lb. cementitious materials
Mid-range Water Reducers			
CATEXOL 300GP	Axim	1.3	2.0
Daracem-65	W.R. Grace & Company	2.0	3.0
Eucon MR	Euclid Chemical Company Distributed by Brett Admixtures	3.9	6.0
MIRA 92	W.R. Grace & Company	1.6	2.5
Polyheed 900	BASF Admixtures, Inc.	2.0	3.0
Polyheed 997	BASF Admixtures, Inc.	3.3	5.0
Polyheed 1020	BASF Admixtures, Inc.	2.0	3.0
Polyheed 1025	BASF Admixtures, Inc.	2.0	3.0
Sikament HP	Sika Corporation	3.3	5.0

BRIDGE FLOOR REPAIR, OVERLAY, & RESURFACING

BRAND NAME	PRODUCER/DISTRIBUTOR	RECOMMENDED MIN. DOSAGE mL/kg cementitious materials	RECOMMENDED MIN. DOSAGE fl. oz./100 lb. cementitious materials
Eucon WR-91	Euclid Chemical Company Distributed by Brett Admixtures	2.0	3.0
Finish Ease NC	RussTech, Inc.	3.3	5.0
LC-400	RussTech, Inc.	2.0	3.0
LC-400P	RussTech, Inc.	2.6	4.0
LC-500R	RussTech, Inc.	2.0	3.0

BRIDGE FLOOR REPAIR, OVERLAY, & RESURFACING (Continued)

		RECOMMENDED MIN. DOSAGE	
BRAND NAME	**PRODUCER/DISTRIBUTOR**	**mL/kg cementitious materials**	**fl. oz./100 lb. cementitious materials**
Master Pave	BASF Admixtures, Inc.	3.3	5.0
Master Pave RI	BASF Admixtures, Inc.	1.3	2.0
Plastocrete 161	Sika Corporation Dist. by Contractors Steel Corp.	2.0	3.0
WRDA-82	W.R. Grace & Company	2.3	3.5
WRDA with Hycol	W.R. Grace & Company	2.0	3.0

***NOTE:** When concrete mobile mixer is used for bridge deck overlay, use same dosage rate per sack of cement.

APPROVED SOURCES
HIGH RANGE WATER-REDUCING ADMIXTURES

		RECOMMENDED MIN. DOSAGE	
BRAND NAME	**PRODUCER/DISTRIBUTOR**	**mL/kg cementitious materials**	**fl. oz./100 lb. cementitious materials**
ADVA 100	W.R. Grace & Company	2.0	3.0
ADVA 170	W.R. Grace & Company	2.0	3.0
ADVA Cast 500	W.R. Grace & Company	2.0	3.0
ADVA Cast 530**	W.R. Grace & Company	2.0	3.0
ADVA Cast 540**	W.R. Grace & Company	3.3	5.0
ADVA Cast 575	W.R. Grace & Company	1.3	2.0
ADVA 140M	W.R. Grace & Company	1.3	2.0
ADVA 190	W.R. Grace & Company	2.0	3.0
Catexol 1000 SPMN	AXIM Concrete Technologies	7.8	12
Catexol 2000 NI	AXIM Concrete Technologies	11.8	18
Catexol Superflux 2000 PC**	AXIM Concrete Technologies	2.0	3.0
Daracem 19	W.R. Grace & Company	5.9	9.0
Daracem 100	W.R. Grace & Company	6.5	10
Eucon 37	Euclid Chemical Company Distributed by Brett Admixtures	7.8	12
Eucon 1037	Euclid Chemical Company Distributed by Brett Admixtures	6.5	10
EXP 950**	W.R. Grace & Company	1.3	2.0
Glenium 3000 NS	BASF Admixtures, Inc.	7.8	12
Glenium 3030 NS**	BASF Admixtures, Inc.	3.9	6.0
MIRA 92	W.R. Grace & Company	1.6	2.5
Glenium 3200 HES**	BASF Admixtures, Inc.	1.3	2.0
Glenium 3400 NV	BASF Admixtures, Inc.	2.0	3.0

HIGH RANGE WATER REDUCING ADMIXTURES (Continued)

		RECOMMENDED	MIN. DOSAGE
BRAND NAME	PRODUCER/DISTRIBUTOR	mL/kg cementitious materials	fl. oz./100 lb. cementitious materials
Glenium 7500*	BASF Admixtures, Inc.	1.3	2.0
Melchem	General Resource Tech.	5.2	8.0
Plastol 341**	Euclid Chemical Company Distributed by Brett Admixtures	2.0	3.0
Plastol 341-S	Euclid Chemical Company Distributed by Brett Admixtures	4.6	7.0
Plastol 5000**	Euclid Chemical Company Distributed by Brett Admixtures	3.0	10
Plastol 5500**	Euclid Chemical Company Distributed by Brett Admixtures	2.0	3.0
Polyheed 1020	BASF Admixtures, Inc.	3.9	6.0
PS 1466**	BASF Admixtures, Inc.	1.3	2.0
Rheobuild 1000	BASF Admixtures, Inc.	9.8	15
Sikament 300	Sika Corporation	15.6	24
Sikament 686	Sika Corporation	2.0	3.0
Supercizer 1	Fritz-Pak Corporation	3.9	6.0*
Supercizer 5	Fritz-Pak Corporation	3.9	6.0*
Supercizer 6	Fritz-Pak Corporation	5.2	8.0*
Supercizer 7	Fritz-Pak Corporation	2.5	4.0*
Superflo 440	RussTech, Inc.	7.8	12
Superflo 443	RussTech, Inc.	6.5	10
Superflo 2000 SCC**	RussTech, Inc.	2.0	3.0

HIGH RANGE WATER REDUCING ADMIXTURES (Continued)

		RECOMMENDED MIN. DOSAGE	
BRAND NAME	**PRODUCER/DISTRIBUTOR**	**mL/kg cementitious materials**	**fl. oz./100 lb. cementitious materials**
ViscoCrete 2100**	Sika Corporation	1.3	2.0
ViscoCrete 4100**	Sika Corporation	2.0	3.0
ViscoCrete 6100**	Sika Corporation	5.2	8.0

*Dry powdered admixture, prepackaged in water-soluble bag.

**These admixtures may be used to make self-consolidating concrete. For such an application, viscosity-modifying admixture may be needed. The selection of viscosity-modifying admixture and rate of the admixtures should be based on manufacturer's recommendations.

APPROVED SOURCES
NON-CHLORIDE ACCELERATING ADMIXTURES

		RECOMMENDED MINIMUM DOSAGE	
BRAND NAME	**PRODUCER/DISTRIBUTOR**	**mL/kg cementitious materials**	**fl. oz./100 lb. cementitious materials**
Accelguard NCA	Euclid Chemical Company	7.8	12.0
CATEXOL 2000 RHE	Axim	6.5	10.0
Daraset 400	W.R. Grace & Company	6.5	10.0
DCI	W.R. Grace & Company	See Manufacturer's Recommendation	
Lubricon NCA (Also acts as a water reducer)	W.R. Grace & Company	6.5	10.0
Plastocrete 161FL	Sika Corporation	3.9	6.0
Polarset	W.R. Grace & Company	5.2	8.0
Plychem Super Set	General Resource Technology	5.2	8.0
Pozzolith NC 534	BASF Admixtures, Inc.	10.4	16.0
Pozzutec 20	BASF Admixtures, Inc.	3.3	5.0
Pozzutec 20+	BASF Admixtures, Inc.	3.3	5.0
Rheocrete CNI	BASF Admixtures, Inc.	See Manufacturer's Recommendation	
Sika Rapid-1	Sika Corporation	5.2	8.0
SikeSet NC	Sika Corporation	6.5	10.0

APPROVED SOURCES
ADMIXTURES FOR PRESTRESSED & PRECAST CONCRETE

BRAND NAME	USAGE	PRODUCER/DISTRIBUTOR	RECOMMENDED MINIMUM DOSAGE mL/kg cementitious materials	fl. oz./100 lb. cementitious materials
Daravair M	Air Entraining	W.R. Grace & Company	1.0	0.67
Quantec PL-490	Plasticizer	W.R. Grace & Company	0.20	0.13

ADMIXTURES FOR DRY-CAST

Eucon BK-S8	Plasticizer	Euclid Chemical Company	1.3	2.0
Eucon DC	Plasticizer	Euclid Chemical Company	1.3	2.0
Rheomix 700	Plasticizer	BASF Admixtures, Inc.	1.3	2.0
Rheomix 730S	Plasticizer	BASF Admixtures, Inc.	1.3	2.0
Rheomix 750S	Plasticizer	BASF Admixtures, Inc.	1.3	2.0
Rheomix 825	Plasticizer	BASF Admixtures, Inc.	1.3	2.0

Iowa Department of Transportation

Office of Materials

October 16, 2007
Supersedes October 19, 2004

Matls. IM 491.14

INSPECTION & ACCEPTANCE
GROUND GRANULATED BLAST FURNACE SLAG (GGBFS)

GENERAL

Acceptance of Ground Granulated Blast Furnace Slag (GGBFS), the glassy, granular material produced when molten blast furnace slag is rapidly chilled, will be on the basis of approved sources and upon satisfactory test results on samples obtained at the project site.

Approval is based upon slag produced when the blast furnace is utilizing specific processes. Any change in the processes will void any source approval and require that a new approval be sought.

SOURCE APPROVAL

Approval of a GGBFS source is based on the requirement of ASTM C989.

A source may furnish Ground Granulated Blast Furnace Slag on the basis of certification provided:

A. The quality-monitoring program meets the minimum sampling and testing frequencies established in ASTM C-989. At least one sample for each 30 consecutive days shall be tested by the producer for conformance to Iowa Department of Transportation Specifications. The test reports for all monitor samples shall be submitted to the Iowa Department of Transportation, Office of Materials, within 45 days of the sampling date.

   The Quality Control Laboratory will be considered approved if it is properly equipped and staffed to perform the tests required for an accepted Quality Control Program. Continued approval of the control laboratory will depend on the comparison of its test results with the Iowa Department of Transportation Central Materials Laboratory. If major differences are found, an attempt to resolve them shall be made as quickly as possible. Continued unresolved differences in test results will be considered a basis for discontinuing control laboratory approval.

B. The Ground Granulated Blast Furnace Slag has shown conformance to the applicable specifications for a continuous period of at least six months.

C. Each shipment of Ground Granulated Blast Furnace Slag is properly certified.

   The supplier of certified Ground Granulated Blast Furnace Slag 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 Ground Granulated Blast Furnace Slag.

Date ______________________ Signed ___________________________

The bills of lading or invoices shall include project number, if available, source name, source location, source code, grade, and quantity of the shipments.

These copies of bill of lading or invoice shall accompany each load, and shall be retained at the project or ready mix plant for the Project Engineer record. 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 mix 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 ground granulated blast furnace slag incorporated in the project. This listing shall bear the signature of a responsible supplier representative.

The source, car or truck number, ticket number, grade, and quantity of each shipment of ground granulated blast furnace slag used on a project shall be recorded on Form #830211, Form #830224, or other applicable form.

D. Monitor samples secured and tested by the Iowa Department of Transportation indicate compliance with current specifications. The District Materials Engineer will obtain yearly samples.

APPROVED SOURCES
GROUND GRANULATED BLAST FURNACE SLAG (GGBFS)

MARKETER	TRADE NAME	PRODUCER LOCATION	GRADE OF SLAG	SPECIFIC GRAVITY	CODE	DISTRIBUTION TERMINALS
Holcim, Inc.	Grancem	Chicago, IL	100	2.87	SL00A	Des Moines, Mason City, Cedar Rapids, Chicago, IL, Lemont, IL, Summit, IL, Rock Island, Lacrosse, WI
Holcim, Inc.	Obourg-Belgium Grancem	LaPorte, CO	100	2.91	SL01A	Des Moines, Mason City, Cedar Rapids, Chicago, IL, Lemont, IL, Summit, IL, Rock Island, Lacrosse, WI
Lafarge, Co.	NewCem	Chicago, IL	120	2.93	SL02B	Davenport, West Des Moines, Omaha, NE
Lafarge, Co.	NewCem	Chicago, IL/ New Orleans, LA	120	2.93	SL03B	Davenport, West Des Moines, Omaha, NE

Iowa Department of Transportation

Office of Materials

October 17, 2006
Supersedes October 19, 2004

Matls. IM 491.17

FLY ASH

GENERAL

Acceptance of fly ash will be on the basis of approved sources and upon satisfactory test results on samples obtained at the project site. Test results of fly ash shall meet the requirements of ASTM C618 and the Specifications of the Iowa Department of Transportation. Approval will require identification of the specific sources of the coal from which the ash is derived.

Approval is based upon fly ash produced when the power plant is utilizing specific materials, equipment, and processes. Any change in materials, equipment, and processes will void any source approval and require that a new approval be sought.

Fly ash produced immediately prior to shut down and after start up may be quite different from the fly ash normally obtained. The fly ash can be affected to the point that it does not meet specifications. Monitor samples or assurance samples tested by the Iowa Department of Transportation not meeting specifications will void the source approval.

SOURCE APPROVAL

A. Certified Source

A source may furnish fly ash on the basis of certification provided:

1. The quality-monitoring program meets the minimum sampling and testing frequencies established in ASTM C311. The tonnage units expressed therein are interpreted to refer to as-marketed material. The producer shall test at least one sample for each consecutive 30 days, for the months of March through October for conformance to Iowa Department of Transportation specifications. The test reports for all monitor samples shall be submitted to the Iowa Department of Transportation within 45 days of the sampling date.

   In addition to the test frequencies established in ASTM C311, daily control tests shall be made to establish the uniformity of the fly ash being produced. Specific tests shall be agreed to by the engineer and may vary from source to source. As a minimum, the loss on ignition and percent retained on the No. 325 mesh sieve shall be determined.

   Sample test records and shipment reports shall be available for inspection by Iowa Department of Transportation personnel for at least three years after the fly ash has been tested.

   The Quality Control Laboratory will be considered approved if it is properly equipped and staffed to perform the tests required for an accepted Quality Control Program. Continued approval of the control laboratory will depend on the comparison of its test results with the Iowa Department of Transportation Central Laboratory. If major differences are found, an attempt to resolve them shall be made as quickly as possible. Continued unresolved differences in test results will be considered a basis for discontinuing control laboratory approval.

2. The fly ash has shown conformance to the applicable specifications for a continuous period of at least the last six months.

3. Available alkali in approval sources of fly ashes shall be less than 1.50%. The value of available alkali in fly ash can be either determined by the test method specified in ASTM C-311, or by statistical formula developed by Central Materials Laboratory based on historical data. Fly ash sources that have available alkali between 1.50% and 2.50% will be approved based on satisfactory results of the following test. Mortar bars made per ASTM C-311 with 15% and 30% fly ash, Type I cement with 0.70% to 0.80% of alkali (Na2O) equivalent, and Pyrex aggregate shall exhibit no more than 10% expansion over non-fly ash mortar bars. Testing shall be performed by a laboratory approved by the Iowa Department of Transportation.

4. Each shipment of fly ash is properly certified.

   The supplier of certified fly ash shall furnish for the project records two invoices or bill of lading copies that 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 Class _____ fly ash.
>
> Date ____________________ Signed ____________________________

The bills of lading or invoices shall include project number, if available, source name, source location, source code, class, and quantity in the shipment.

These copies of the bill of lading or invoice shall accompany each load, and shall be retained at the project or ready mix plant for the Project Engineer records.

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 mix 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 fly ash incorporated in the project. This listing shall bear the signature of a responsible supplier representative.

The source, car or truck number, ticket number, ash type, and quantity of each shipment of fly ash used on a project shall be recorded on Form #830211, or Form #830224, whichever is applicable.

5. Monitor samples secured and tested by the Iowa Department of Transportation indicate compliance with current specifications.

6. Percent Available Alkali

   The percent available alkali listed in Appendix A shall be used in calculating the alkali level of the cementitious materials and for proportions for concrete mixes on construction projects when specified. Any adjustments in mix proportions shall be the responsibility of the contractor, and approved by the engineer.

7. Co-Mingling of Fly Ash

   Mixing of fly ash from different sources, different plants, or different types into one storage bin or silo will not be allowed. At ready mixed concrete plants and paving batch plants, a fly ash storage bin shall be emptied, as far as practical, prior to refilling from a different source.

B. Sources for Pavement Subsealing and Jacking

1. Fly ash to be used for pavement subsealing and jacking may be accepted on an approved source basis as listed in Appendix B.

2. A mixture of 3 parts fly ash and 1 part Portland Cement shall have an initial setting time between 30 minutes and 3.0 hours. Initial set is defined as 100-psi resistance when measured in accordance with ASTM C403.

PROJECT ASSURANCE SAMPLING

Required 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 fly ash on certification basis. Construction, which contains fly ash represented by assurance samples, which show deficient test results, will be subject to the requirements of Article 1105.04 of the Standard Specifications.

Depending upon certain chemical characteristics, fly ash is marketed as either Class F (non-cementing) or Class C (self-cementing) ash. The identification submitted with the assurance samples sent to the Central Laboratory should include the normal descriptive information as well as the source of the ash, the marketer and the class of the ash.

Precautionary measures shall be taken to prevent cement contamination of fly ash samples obtained at the proportioning plants. The samples shall be taken preferably as follows:

1. Directly from the delivery transport vehicles

2. Drop a sufficient amount of material in a clean container or a clean end loader bucket, and obtain a representative sample.

APPROVED CERTIFIED SOURCES
Class C Fly Ash

Source	Class Ash	Nearest City	Marketer	Specific Gravity	%Available Alkali	Code
Burlington Generating Station	C	Burlington, IA	Headwaters Resources, Inc.	2.79	1.55	FA000C
Coal Creek Power Plant*	C	Bismark, ND	Headwaters Resources, Inc.	2.56	0.75	FA003C
Columbia Generating Station #1	C	Portage, WI	Lafarge North America	2.79	0.99	FA001C
Columbia Generating Station #2	C	Portage, WI	Lafarge North America	2.60	1.15	FA002C
Council Bluffs Unit #3	C	Council Bluffs, IA	Headwaters Resources, Inc.	2.64	1.06	FA004C
Edgewater Unit 5 Generating Station	C	Sheboygan, WI	Lafarge North America	2.66	0.93	FA020C
Geral Gentleman Station, Unit #1	C	Sutherland, NE	Nebraska Ash	2.65	1.23	FA028C
Hawthorn Generating Station	C	Kansas City, MO	Lafarge North America	2.61	1.21	FA006C
Iatan Generating Station	C	Weston, MO	Lafarge North America	2.77	0.95	FA007C
Lansing Generating Station	C	Lansing, IA	Headwaters Resources, Inc.	2.77	0.96	FA008C
Louisa Generating Station	C	Grandview, IA	Headwaters Resources, Inc.	2.70	1.14	FA009C
Muscatine Power & Water	C	Muscatine, IA	Lafarge North America	2.77	0.55	FA010C
Nebraska City Station	C	Nebraska City, NE	Nebraska Ash	2.57	1.25	FA011C
North Omaha Generating Station	C	Omaha, NE	Nebraska Ash	2.71	1.23	FA012C
Ottumwa Generating Station**	C	Chillicothe, IA	Headwaters Resources, Inc.	2.73	1.75	FA013C
Pleasant Prairie Generating Station	C	Kenosha, WI	Lafarge North America	2.50	1.05	FA014C
Port Neal #3	C	Sioux City, IA	Headwaters Resources, Inc.	2.71	1.17	FA015C

*This fly ash has greater than 66.0% of total oxides ($SiO_2 + Al_2O_3 + Fe_2O_3$), and greater than 38.0% of SiO_2.

**The fly ash co-fired with up to 5% switch grass is allowed for this source.

Class C Fly Ash (Continued)

Source	Class Ash	Nearest City	Marketer	Specific Gravity	%Available Alkali	Code
Joppa Power Plant	C	Joppa, IL	Mineral Resource Technologies, LLC	2.69	1.48	FA023C
Labadie Power Plant	C	Labadie, MO	Mineral Resource Technologies, LLC	2.71	1.02	FA022C
Labadie Power Plant	C	South Beloit, MO	Mineral Resource Technologies, LLC	2.71	1.02	FA024C
M.L. Kapp	C	Clinton, IA	Headwaters Resources, Inc.	2.76	1.11	FA018C
Port Neal #2	C	Sioux City, IA	Headwaters Resources, Inc.	2.63	1.43	FA029C
Port Neal #3	C	Sioux City, IA	Headwaters Resources, Inc	2.16	1.17	FA015C
Port Neal #4	C	Sioux City, IA	Headwaters Resources, Inc.	2.66	0.89	FA016C
Rush Island Power Plant	C	Festus, MO	Mineral Resource Technologies, LLC	2.83	1.37	FA021C
Thomas Hill Energy Center	C	Clinton Hill, MO	Headwaters Resources, Inc.	2.62	1.36	FA025C
Weston Units	C	Weston, WI	Lafarge North America	2.68	1.30	FA026C

Class F Fly Ash

Source	Class Ash	Nearest City	Marketer	Specific Gravity	%Available Alkali	Code
Joliet	F	Joliet, IL	Lafarge North America	2.54	N/A	FA017F
Monticello	F	Monticello, TX	Boral Material Technologies	2.42	0.44	FA021F

APPROVED FLY ASH SOURCES FOR PAVEMENT UNDERSEALING & JACKING

SOURCE	**CLASS ASH**	**NEAREST CITY**	**MARKETER**	**CODE**
Hawthorn Generating Station	C	Kansas City, MO	Lafarge North America	FA006C
Lansing Generating Station	C	Lansing, IA	ISG Resources, Inc.	FA008C
Louisa Generating Station	C	Grandview, IA	ISG Resources, Inc.	FA009C
Muscatine Power & Water	C	Muscatine, IA	Lafarge North America	FA010C
Nebraska City Station	C	Nebraska City, NE	Nebraska Ash	FA011C
North Omaha Generating Station	C	Omaha, NE	Nebraska Ash	FA012C
Pawnee Power Plant	C	Ft. Morgan, CO	Western Ash	FA026C
Pleasant Prairie Corporation	C	Kenosha, WI	Lafarge North America	FA014C

October 19, 2004
Supersedes October 26, 1999

Matls. IM 525

DESIGNING FLOWABLE MORTAR

GENERAL

The design of flowable mortar involves determining the proper proportions to obtain the required flow characteristics.

MATERIALS

Obtain representative samples of the following materials from the producing ready mix plant:

Sand	(75 lb.) 34 kg
Portland Cement	(15 lb.) 7 kg
Fly Ash	(15 lb.) 7 kg

PROCEDURE

A. Apparatus

1. Flow cone and equipment specified in IM 375
2. Mixer 4 qt. (4.5 L) or larger
3. 1,000 mL cylinder
4. Spatula
5. Equipment specified in IM 302
6. 1 mL pipette

B. Test Samples

1. Obtain samples for the sieve analysis and the trial mixes by one of the quartering methods listed in IM 302.
2. Two samples of at least 4,600 grams should be obtained for the trial mixes. Do not attempt to select a sample of an exact predetermined mass.

C. Preparation of Samples

1. Oven dry the samples to a constant mass and allow to cool. Screen the sample over a No. 4 (4.75 mm) sieve to remove over-sized material.
2. Weigh the dry sand samples to the nearest gram and calculate the cement and fly ash

batch weight (mass) as follows:

$$\text{Cement Mass} = \text{Sand Mass} \times \frac{(60\ \text{kg/m}^3)}{1550\ \text{kg/m}^3} \qquad \text{Cement Weight} = \text{Sand Weight} \times \frac{(100\ \text{lb./yd.}^3)}{(2600\ \text{lb./yd.}^3)}$$

$$\text{Fly Ash Mass} = \text{Sand Mass} \times \frac{(180\ \text{kg/m}^3)}{1550\ \text{kg/m}^3} \qquad \text{Fly Ash Weight} = \text{Sand Weight} \times \frac{(300\ \text{lb./yd.}^3)}{(2600\ \text{lb./yd.}^3)}$$

Air entraining agent at 1 oz./cu. yd. (38.7 mL/m^3)

$$\text{mL of Air Agent} = \text{Sand Mass} \times \frac{38.7\ \text{mL/m}^3}{1550\ \text{kg/m}^3}$$

$$\text{mL of Air Agent} = \text{Sand Weight} \times \frac{1\,\text{oz./cu. yd.} \times 29.57\ \text{mL/oz.}}{2600\ \text{lb./cu. yd.} \times 453.6\ \text{lb./gm}}$$

D. Mix Procedure

1. Add the air-entraining agent to the mixing water. Add the sand and part of the needed mixing water to the bowl. Start the mixer and add the cement, fly ash, and water. Add water until the mix appears fluid. Mix for three minutes after adding all materials.

   When too much water is added, the water and solids will separate after mixing. If too much water is added on the initial trial, the mix should be discarded. A good starting point for the water is 70 gallons per cubic yard (350 liters per cubic meter). The batch volume of water would be:

$$\text{mL of water} = \text{sand mass} \times \frac{(350\ \text{L/m}^3)}{1550\ \text{kg/m}^3}$$

$$\text{mL of water} = \text{sand weight} \times \frac{(70\ \text{gal./yd.}^3)(8.34\ \text{lb./gal.})}{2600\ \text{lb./yd.}^3}$$

2. Record the amount of water added. Run the flow test as per IM 375 to obtain the efflux time.

3. If the time of efflux is too long, increase the amount of water, air-entraining agent, or fly ash to improve the flow on the second trial. If additional water causes separation of the water and solids, fly ash should be added in 100-lb. (60-kg) increments up to a total of 400 pounds per cubic yard (240 kg per cubic meter). Air-entraining agent should be added in 0.5-oz. (19.35-mL) increments up to a total of 2 oz./cu.yd. (77.4 mL/m^3). <u>Some sands will not produce satisfactory mix and will need to be rejected.</u>

E. Calculations and Reporting

1. Determine the final mix design weights as follows:

$$\text{Fly Ash Mass} = \frac{\text{(grams fly ash used)}}{\text{(grams sand)}} \text{ x } 1550 \text{ kg/m}^3$$

$$\text{Fly Ash Weight} = \frac{\text{(grams fly ash used)}}{\text{(grams sand)}} \text{ x } 2600 \text{ lb./yd.}^3$$

$$\text{Water (Liter)} = \frac{\text{(mL water used)}}{\text{(grams sand)}} \text{ x } \frac{1550 \text{ kg/m}^3}{1 \text{kg/L}}$$

$$\textit{Water} \text{ (Gallons)} = \frac{\text{(mL water used)}}{\text{(grams sand)}} \text{ x } \frac{(2600 \text{ lb./yd.}^3)}{(8.34 \text{ lb./gal.})}$$

Portland Cement = 100 lb. (60 kg)   Sand = 2600 lb. (1560 kg)

Air-Entraining Agent # oz./cu. yd. (#mL/m³)

2. Report the time of efflux to the nearest 1 second. The test report should be issued like the report in the Appendix.

EXAMPLE:

IOWA DEPARTMENT OF TRANSPORTATION
NWITC - Materials Laboratory
Test Report - SAND
Sioux City, Iowa

MATERIAL: 1-4110 sand

INTENDED USE: Flowable Mortar

LAB NO.: 3FM6-3002

DATE REPORTED: 10/28/96

SOURCE: Higman's Sand & Gravel, Akron

QUANTITY: 30 cubic meters

COUNTY: Plymouth

PROJECT: STPN-12-2(13)--2J-75

DESIGN: —

CONTRACT: 73512

PRODUCER: Joe's Ready Mix

CONTRACTOR: Brower Construction.

UNIT OF MATERIAL: 75# sack
Use with LaFarge Portland Cement with Midwest Fly Ash Port Neal #4

SAMPLED BY: C. Fenceroy **SENDER'S NO.** CF10-24-96-5 **DATE SAMPLED:** 10/24/96 **DATE REC'D:** 10/24/96

Sieve Analysis	%
3/8	100
#4	99
#8	88
#16	65
#30	35
#50	11
#100	1.3
#20	0.7

CC: Materials - Ames, Geology, R. Kalsem, C. Narotam, Proj. Engineer, Contractor, Source, Producer, Lab, Proj. File

Disposition: Complies only with the following proportions: 100 lbs. cement, 300 lbs. fly ash, 2600 lbs. sand. Flowability obtained in 15.9 seconds with 66 yd3 H2O

SIGNED: ____________________
C. E. Leonard, NWITC Materials Engineer

PAVING PLANT INSPECTION

GENERAL

The following instruction is to be used when inspecting the operation of a PC Concrete paving plant.

Materials and proportions must be controlled in accordance with the specifications and the following detailed instructions.

The plant inspector will normally be assigned the following duties:

1. Inspection or monitoring of proportioning and of plant operation
2. Gradation determination of the aggregates used
3. Identification and tabulation of materials received and used
4. Protection, curing, and testing of the strength specimens, and care of the specimen forms
5. Maintenance of a daily diary and preparation of the Daily Plant and Strength Reports

Certified Plant Inspectors will assume a number of duties, as specified in IM 213.

The contract documents provide for the class of concrete to be used in a given project. Standard and slip form are the two types of pavement specified. All classes of concrete contain entrained air to improve durability. Unit absolute volume proportions for the four classes of concrete and the various mix numbers are provided in IM 529. The class of concrete is designated in the contract documents and the Contractor may use any of the numbered mixes designated in the respective class of concrete. The gradation of the coarse aggregate must comply with the requirements of the mix number chosen.

The Engineer will see that the inspector is provided with proper equipment for carrying on the work, except the Certified Plant Inspectors will provide their own equipment. Furnished equipment will be provided upon request from the Ames Laboratory and the Inventory Management storerooms. Requests for equipment or supplies to be checked out must be made on Iowa Department of Transportation Stock Issue Form #133005.

The following statement shall apply to all phases of equipment and material testing and/or examinations:

> Tests and/or examinations must be made at least as frequently as described herein or in other applicable memorandums. All test and examination results are to be recorded in the Plant Inspector Field Book. All field books and records shall become the property of the Contracting Authorities at the completion of the project.

If a test result on a project acceptance or control sample indicates specification noncompliance, appropriate action in accordance with the applicable specifications, instructional memorandums, and resident engineer instructions shall be taken. (See IM 204.) Normally, the Contracting Authority will issue a Form #830246, Noncompliance Notice.

It must be noted that the Contractor is responsible for deciding what corrective action must be taken, for directing that it be taken and for the results. The inspector must not in any way assume responsibility for the corrective action or its results.

It is the inspector's responsibility, based on prescribed tests and examinations, to monitor the progress of the work, to make available to the Contractor the results of tests and examinations on a continuing basis and to inform the Engineer and Contractor when tests show noncompliance. The Contractor is responsible for furnishing compliant material and finished work.

A checklist of the detailed plant inspection duties is included as part of these instructions. Refer to this checklist before the work begins, and periodically thereafter, to be certain that all the required tests and inspection procedures are being included in the routine activities.

SAFETY

Safety should be uppermost in the minds of those working in a concrete plant. In the past there have been injuries and even deaths, because proper attention was not given to safety details. Certain requirements have been made a part of the contract documents as safety measures. It is not possible, however, to remove all unsafe conditions from a paving plant situation.

The plant inspector must make certain all contractual requirements are met, including those related to safety. The inspector should encourage the elimination of hazards not specifically covered by the specifications. Some hazards will be impractical to remove. The inspector should be familiar with these hazards and thus be better able to protect against them. Protective headgear should be worn when working around bins and other plant equipment.

Safety considerations mandate that stopped belt sampling locations must be equipped with an on-off switch near and in plain view of the sampling point. This switch must have sole control of the sampling belt when the switch is in the off position.

EQUIPMENT

1. BINS

   The following requirements shall apply to bins used in connection with the production and delivery of materials and to bins used in connection with the proportioning of materials for mixtures. The Standard Specifications in Article 2001.06 authorize the Engineer to examine the bin each time it is erected for use.

The Contractor shall maintain any stress-carrying parts of the bin frame, which support the load in proper working condition. No stress-carrying member shall be absent while the bin is in use. All members must be straight and full-size. If any member has become bent or deformed, it shall be straightened by methods, which will not injure the material, or a new member must replace it. Piles of aggregate shall be kept from introducing stresses into the bin legs caused by lateral pressure against the legs. If all footings under one bin settle uniformly after the bin has been loaded, the settlement is not considered a problem. However, if the settlement differential of the footings under one bin exceeds 1/10 foot (30 millimeters), the District Materials Engineer must be informed.

The Contractor shall periodically observe the bin for settlement after the bin has been loaded. Before concrete proportioning at a new plant installation, the bins should have been fully-loaded for at least 12 hours and the amount of settlement determined by the contractor. Checks of settlement by the contractor shall be furnished to the Engineer. If a scale is affected by the above unequal settlement, its operation must also be re-evaluated.

All conveyers and other plant machinery shall meet current OSHA Standards. The Contractor shall be responsible for complying with these requirements for both design and erection. The Contractor shall furnish a certification or design calculations to the Engineer to confirm compliance, if requested to do so.

2. PROPORTIONING EQUIPMENT

Requirements for scales or meters for proportioning aggregates, cement, fly ash, water, or admixtures are found in Article 2001.20 of the Standard Specifications. These essential requirements are in addition to the safety requirements referred to in Section 1 above for bins.

When a proportioning plant has been moved and set up, it is essential that the proportioning scales are test loaded and the proportioning meters are tested for specification compliance.

Proportioning scales and meters shall be test loaded to the maximum load expected during production. Proportioning during production shall not exceed the maximum load tested during calibration.

It is the duty of the District Materials Engineer or designated staff to witness calibration of all proportioning and plant equipment before concrete work begins. The plant inspector is encouraged to be present while the scales and other equipment are being tested and evaluated.

When it has been determined that all proportioning devices and plant equipment comply with the specification requirements, a Plant Calibration Report, Form #820917, will be prepared by the contractor's representative and signed by the District Materials Engineer, or representative, as a witness to the calibration. This report authorizes the use of the plant to which it applies and the materials and proportions listed thereof. It is to remain at the plant in the inspector's files during progress of the work. A sample copy of Form #820917 is shown later in Appendix C and a calibration checklist is shown in Appendix D. The plant inspector must be familiar with all features of the plant operation before the work begins. While the inspector must not personally make any of the plant manipulations or adjustments, understanding the basic machinery operation and being able to recognize the significance of a malfunction is important.

The proportioning equipment must be examined at least at **3-hour intervals** for correctness of the **amount being batched** and for damage of the equipment. Special attention must be given to the empty balance and the position of the poises for beam and dial scales. The normal plant operation causes vibration, which tends to change these adjustments.

Accumulation of material clinging to the inside of the hopper can also cause these adjustments to drift. Small amounts of material accumulation clinging to the inside of the hopper are not considered objectionable. If the amount exceeds one percent of the material batch mass, however, it must be removed and the indicator on the empty hopper readjusted to indicate a zero load within ± 0.5% (See Article 2001.20). The **scale sensitivity** shall be checked **at least twice during a normal working day** by placing a mass equal to 1/10 percent of the batch on the fully-loaded scales and observing the movement of the indicator. A properly sensitive scale will exhibit a visible indicator movement when so tested. If no indicator movement is visible and immediate corrective action by the Contractor does not yield successful results, the District Materials Engineer must be informed.

The following procedure is required for setting or adjusting the various items of proportioning equipment in order that they will deliver the proper amount of material to the batch:

1. The plant superintendent or other authorized contractor representative must make all necessary scale and equipment settings and/or adjustments. The plant inspector is specifically directed not to participate in this activity.
2. Before the plant operation begins or resumes, the plant inspector will independently determine that the settings and/or adjustments are accurate and that the masses of material being delivered to the batch are correct. Errors must be corrected immediately.

Strict adherence to the above procedure is necessary to maintain a proper division of authority and responsibility between the Contractor and the Contracting Authority and to minimize the possibility of operating with erroneous proportions.

Suitable wind protection on all sides of the scales is required by the specification. This protection, if not provided by the plant design, can be fabricated from burlap, Masonite, plywood or other suitable material and should provide adequate room for the scale operator to work unobstructed.

a. CEMENT & FLY ASH SCALES. Cement and fly ash scales at the contractor proportioning plant are usually required to be automatic. (See Article 2001.20 and 2301.13.) The scales must be **accurate** to within **plus or minus 0.5%** of the load and must operate (**delivery tolerance**) within **plus or minus 1%** of the required batch.

   The scale accuracy is determined prior to the beginning of concrete work by the District Materials Engineer or representative and in most cases will need no further attention.

The delivery tolerance, however, can be determined only when the automatic device is in operation. A number of suitable procedures for determining delivery tolerance have been devised. While one procedure may not be suitable for all scale installations, the following is suggested, because it can be applied to the majority of the cement proportioning equipment used. Modifications of the procedure are permitted providing the delivery tolerance is determined.

1) With the hopper loaded to the correct amount for one batch, the addition of material to the hopper equal to one percent of the correct batch must cause the "over" limit switch to function and prevent automatic discharging of the batch.

2) With the hopper loaded to the correct amount for one batch, the removal of material from the hopper equal to one percent of the correct batch must cause the "under" limit switch to function and prevent automatic discharging of the batch.

Check scale operations to determine **delivery tolerance** conformance at least **once** during **each day** of normal operation.

Minor adjustments of numerous phases of the automatic batching cycle are normally required on a continuing basis because of changing weather and material conditions. The inspector must become intimately familiar with the automatic scale operation to be able to recognize when these minor adjustments are needed. As a general rule, if the operator has to manually adjust the amount of material in the hopper or charge or discharge manually more often than once in each ten batches the automatic measuring device needs repair, adjustment, or servicing. A 24-hour grace period is provided during which manual operation is permissible. Specific approval of the engineer is required for continued manual operation beyond the 24-hour grace period. The engineer's approval should be based on a consideration of the following:

- Immediate steps were taken to repair the automatic malfunction.
- If repair within the 24-hour period is not possible and beyond the control of the Contractor and the malfunction could not reasonably have been anticipated.
- Manual measuring is within the accuracy required for automatic scales.
- It would be to the advantage of the contracting authority for the paving operation to continue.

Manual measuring of cement shall be under the constant surveillance of the inspector. The empty scales must be tare-balanced after discharging each batch and before charging another.

Cement Yield Check

The Standard Specification requires that the cement shipment yield determination must be made at intervals of approximately 10,000 cubic yards (10,000 cubic meters) after the original determination made near the end of the first full day of production. When a permanent, commercial-ready mix plant is dedicated to furnish greater than 10,000 cubic yards of continuous concrete production, cement yield determinations are required. When a permanent, commercial-ready mix plant furnishes greater than 10,000 cubic yards on an intermittent basis, cement yield determinations shall be at the option of the District Materials Engineer. If fly ash is batched on the same scale as cement, no yield determination is needed for the fly ash.

The purpose of the cement yield test is to compare the amount of cement, which is measured, on the contractor's batch scales with the amount, which is measured on the scales at the cement manufacturing plant. The assumption is made that the mass shown by the manufacturer (billed amount) is correct.

The cement storage bin or bins must be empty and free of cement before the test is started. In the event a bin is partially filled with cement left over from a previous project, it should be used and the bin completely empty before the yield determination is started. The removal of all cement from the bins provides the necessary starting point in addition to assurance that cement lumps and foreign debris have been eliminated.

Make the first cement yield near the end of the first full day of production, being sure each cement car or truck is completely empty after unloading into the storage bin.

At the end of the test the storage bin must be completely empty again. Estimating the amount of cement in a storage bin is not suitable and by doing so the test result is virtually meaningless.

A careful record must be made of the total batches used and from this figure calculate the total cement batched. Also calculate the yield expressed as a percent of the billed total.

If the yield percent is less than 99.0, or greater than 101.0, refer to the section entitled, General, in this IM for special action required. If the results of the first test are within the above limits no special action is necessary. Follow the same procedure for following yield tests, except extend the test over about 10,000 cubic yards (10,000 cubic meters) intervals of work. For the longer interval tests, the amount of cement in a bin at the beginning and ending can be estimated without introducing appreciable error. Report each cement yield test performed on Form #820912, Portland Cement Shipment Yield Report. (See sample Yield Report in Appendix C).

b. AGGREGATE SCALES. Aggregate scales may be operated either manually or automatically and must operate within a **delivery tolerance** of plus or minus **one percent** of the required batch amount. If the scales are operated automatically, the delivery tolerance can be determined in the same manner described in 2a, Cement Scales. If it is operated manually note the location of the balance indicator or dial indicator when a one percent over and under load is added to and subtracted from the correct amount in the hopper. Aggregate delivered to the batch must be within the above limits. Check scale operation to determine **delivery tolerance** conformance at least **once during a normal working day**.

c. WATER MEASURING DEVICE. Scales or volume meters are permissible for measuring water. Scales may be operated manually or automatically. Regardless of the type of measuring equipment used, the amount of water delivered to the batch must be **accurate** to **2.2 lbs. (1 kg)** or within plus or minus **one percent** of the amount shown by the indicator whichever is greater. If water is measured with a scale, the **delivery tolerance** must be determined at least **once for each day** of normal operation as described in 2b, Aggregate Scales. If a volume meter is used, the delivery tolerance need not be determined other than during the original calibration or at such time that a water-measuring problem is indicated. Testing a water meter is the duty of the District Materials Engineer or his/her representative.

d. ADMIXTURE DISPENSING EQUIPMENT. Admixtures (air or water reducing) may be proportioned manually or by automatic equipment. If they are proportioned manually, the method and procedure must be approved by the engineer and should be performed by a person having no other duties. If they are proportioned automatically, the dispensers must be equipped with a transparent chamber that will permit visual observation of the admixtures as they are introduced into the batch. The visual inspecting chamber requirement may be waived in lieu of admixture dispensing systems utilizing positive electronic flow metering and computer controlled delivery that prevents improper admixture incorporation into the mix. Equipment for dispensing liquid admixtures shall be accurate within plus or minus 3.0 percent of the quantity required. The operation of the dispenser when operated either manually or automatically must be observed for uniform **delivery** at least **once during each 3 hours** of normal operation. The dispensing equipment must be flushed with water at least once daily to minimize the possibility of material accumulation that will impair the equipment performance. The use of malfunctioning dispenser equipment will be discontinued immediately upon detection of the malfunction and its use must not be resumed until the malfunction has been eliminated. If a problem with the air agent dispenser develops, the first indication of it will likely appear as a problem controlling the air content in the plastic concrete. The air content may be variable from one batch to another or it may be uncontrollable in either the high or low range. If immediate corrective action does not yield satisfactory results the engineer in charge and/or the District Materials Engineer must be informed. Concrete work must not be permitted to continue if air test results show specification non-compliance. There are no such indicators in plastic concrete for water-reducing admixtures. Therefore, as mentioned above, the dispenser operation must be observed regularly.

3. MIXING EQUIPMENT

Central mixer is the most popular, and is the type normally used when high production is desired, ready mix trucks are used for limited amounts of pavement, and mobile mixers are typically used in bridge deck overlays.

Mixing equipment for paving projects will be one of the following types as described in Article 2001.21:

a. CENTRAL MIXERS. For central mixers, the maximum batch size and the mixing speed recommended by the manufacturer are shown on the Mixer Manufacturer Bureau (MMB) rating plate that is attached to the mixer. The batch size shall not exceed that recommended on the MMB plate and the rotational speed of the mixer drum shall be at least equal to that shown on the MMB plate. After all materials are in the mixer, the mixing time shall be a minimum of 60 seconds and a maximum of 5 minutes.

The following is the recommended method for determining mixing time:

There are three parts of the batch cycle; the charging of the drum, the mixing, and the discharge. In order to check the mixing time; first determine the time required to add all ingredients to the mixing drum. Then determine the time to discharge, from the time the first concrete falls out of the drum into the delivery vehicle until the drum is back into the mixing position and material begins to be charged into the drum. The charge time plus discharge time plus a minimum mixing time of 60 seconds is the minimum batch cycle time.

The mixing time must be determined and recorded at least once per day by the Certified Plant Inspector. By timing the batch cycle and subtracting the charge time and discharge time, the mixing time can be determined. Determining the average cycle times over a number of batches where the batching operation is running uninterrupted is preferable. The total batch cycle time, as well as the time needed for charging and discharging, should also be recorded initially for a given batch size. This enables mixing time to be determined through timing of the total batch cycle.

The batch cycle time may change if the size of the batch changes. The size of the batch should be noted if changes in the cycle time are found.

The monitor inspector should check the mixing time when visits are made to the project. The monitor should then compare the determined mixing time to those recorded by the Certified Plant Inspector. The contractor is required to furnish individual batch tickets or a daily summary of the materials in each batch and the time the batching begins or in the case of batch tickets, the time of discharge of each batch.

If the mixing time is less than 60 seconds, an immediate correction must be made.

b. READY MIX. The maximum size of the batch and the mixing speed recommended by the manufacturer for ready mix trucks shall be shown on a plate attached to the mixer. The Truck Mixer Manufacturer's Bureau (TMMB) may issue the plate; if not, an independent, recognized laboratory, shall determine compliance as defined in Article 4103.01, and complete test results may be required. The batch size must not exceed that shown on the plate and the mixing speed must be in the range shown. Determine and record the mixing speed for each mixer at least once daily. The batch must be mixed from 70 to 90 revolutions at mixing speed unless otherwise directed by the engineer. All mixers must be equipped with a revolution counter. If the counter is one that counts revolutions only when the drum is turning at mixing speed, mixing may be permitted while the truck is in transit. If the counter is a simple re-settable counter, which counts all revolutions regardless of the drum speed, mixing must be accomplished at a location where it can be observed by the inspector. It is permissible for the mixing to be done either at the plant or the project site. A clear understanding must exist between the plant and grade inspectors as to where the mixing will be done.

Ready mix trucks must carry, in the vehicle; a current certification signed by a responsible company representative stating that the mixer condition has been examined during the previous 30 days, and is free of hardened concrete and is in proper working condition. Mixers not carrying the required certification must not be used.

4. TRANSPORTATION VEHICLES

a. CENTRAL MIXING. When the concrete is centrally mixed it may be transported in either agitating or non-agitating hauling units. If non-agitating units are used, the fresh concrete must be placed on the grade within 30 minutes after it has been discharged from the mixer. If agitating units are used, the fresh concrete must be placed on the grade within 90 minutes after the water and cement have made contact with each other (See Article 2301.13.D.1).

When approved by the engineer, an approved retarding admixture may be used at the rate prescribed in IM 403, and the mixed-to-placed time period, for concrete transported without agitation, may be extended an additional 30 minutes.

b. READY MIX. When the concrete is mixed in ready mix trucks and agitated thereafter, the fresh concrete must be placed on the grade within 90 minutes after the water and cement have made contact with each other. If continuous agitation is not used, the time limit is 30 minutes (See Article 2301.13.D.2.). For pavement patching, ready mix concrete must be placed within 30 minutes or 90 minutes when retarder is used (See Articles 2529.02.B.8 and 2530.03.B.2.). Concrete, which has been mixed, agitated or held in excess of the above time limits, must not be used.

Determine and record the cement to **water contact time** at least **once during each day** of normal operation.

MATERIAL

1. IDENTIFICATION

Arriving shipments of material must be examined for damage and contamination. Before material is incorporated into the project, the inspector must be assured that approval reports for the material have been received or will be received shortly.

For shipments of cement and fly ash the inspector shall examine the invoice or bill of lading that is attached to the tanker when shipments arrive. When nighttime delivery occurs, the inspector shall examine the invoice or bill of lading before production begins on the next working day. The inspector must be ensured the proper material is placed in the proper storage unit.

An orderly record showing when the shipment arrived, the amount and identification of material involved and the laboratory report number, invoice number, ticket number, on which the material has been approved is necessary for documenting that material used has been tested and approved. Telephone conversations regarding material approval must also be summarized in this record. Keep a similar record for aggregates, and admixtures.

The inspector will not permit any material to be used or stored with accepted material until the inspector is satisfied the material is acceptable.

a. AGGREGATES. Certified aggregate may be incorporated into a project on the basis of the certified truck ticket. When the material represented is non-proportioned aggregate the project number must show on the truck ticket and a copy furnished for project inspection personnel. When the material represented is proportioned aggregate, the project number is preferred when practical as in the case when shipping to a paving plant site and not required when impractical as in the case when shipping into warehouse stock at a ready mix plant. A file of proportioned aggregate tickets will be maintained by the contractor and made available for inspection at each plant or project site during the project period. The plant inspector shall verify that all material incorporated in the project is properly certified and document this verification and quantity on each of the appropriate daily or periodic construction reports. No other project documentation for the incorporated aggregate is required (See IM 209).

b. CEMENTITIOUS MATERIAL. Cement, fly ash, and Ground, Granulated, Blast Furnace Slag (GGBFS) may be incorporated into the project on the basis of the manufacturer certification. (See IM 401, 491.17, and 491.14.)

c. WATER. Water secured from streams, lakes, and other non-potable sources ~~must~~ will be tested and approved by the Central Laboratory before it is used. Water from municipal supply systems and other potable sources may be used without testing provided the source is documented.

d. ADMIXTURES. Admixtures may be incorporated into the project without further sampling and testing if they are listed in IM 403.

e. Approved brands of water reducing admixtures, retarding admixtures, and dosage rates are in IM 403. Any admixtures suspected of being frozen and materials older than 18 months shall not be used before being tested and approved. These admixtures shall be **mixed** thoroughly **once a day** prior to proportioning to maintain the solids in suspension. The mixing shall be done in such a way that the solution in the holding or storage tank is circulated for a minimum of 5 minutes each day per 100 gallons (380 liters) of solution or any fraction thereof. A circulating pump with 250 watts (1/3 hp) pump motor and a 5/8-in. (16-mm) inside diameter hose will be considered as a minimum requirement. The engineer shall approve the method of mixing and the plant inspector shall witness the mixing process.

NOTE: A stream of air bubbles will not be acceptable. Proper storage of the admixtures during the winter months is recommended to avoid freezing of the material.

2. STORAGE & HANDLING OF MATERIALS

The contractor shall notify the Engineer of the stockpiling procedures to be used and of the date when stockpiling will begin. This shall be done ahead of commencement of stockpiling in order to allow discussion of procedures and inspection of the stockpile sites and dumping areas. District Materials personnel may also be a part of this review and inspection.

The storage and handling of all aggregates must comply with Article 2301.13. If alternate methods are used as permitted and the required sampling and testing indicates non-specification aggregate gradation, the District Materials Engineer must be informed immediately. The responsibility of and the authorization for proper changes, if necessary, lies with the District Materials Engineer. It is important that the moisture content of the aggregates be uniform. Fine aggregate must be drained at least 24 hours before it is placed in the batch. For both coarse and fine aggregate, moisture content of successive batches must not vary more than 0.5 percent or this will be considered non-compliant. In such a case, the engineer and the contractor must be immediately informed. The problem must be corrected within a reasonable amount of time, generally one day. The work must not be permitted to progress when such a problem is not corrected. Unless aggregates are stored on platforms or other smooth hard surfaces some material in the bottom of the pile will be unfit for use because of contamination by the underlying soil. (See Article 2301.13.)

Aggregates may become contaminated or degraded from a number of sources. Examples of these are foreign material from the pit or quarry, foreign material in the rail cars or other hauling units, boards or bags used to plug holes in rail cars, and degradation from handling or prolonged storage. When aggregates are being taken from the lower portion of the pile, particularly when the work is approaching completion and the stockpiles are small, the inspector must be continually alert and forbid the use of contaminated aggregates. The inspector must understand that all of the above sources and numerous others can furnish objectionable contaminants. If contamination does occur, the aggregates affected must not be used.

Cement, fly ash, and GGBFS must be stored in weatherproof enclosures, which will protect against dampness. If lumps develop in the cement or fly ash it must not be used until it has been reprocessed, re-tested and approved as provided in Articles 4101 and 4108. Cement, fly ash, and GGBFS, which has been in storage more than 60 days at the project site or in the producer silo for more than a year must also be re-tested and approved.

SAMPLING & TESTING

1. AGGREGATES

The explanation below describes the sampling and testing required for proper plant inspection. IM 204 describes the minimum sampling and testing frequencies required for the inspection of construction projects.

a. SAMPLES. Aggregate samples are necessary to determine moisture content, specific gravity, and gradation. Care must be taken to ensure that the samples are representative of the materials being used. Secure fine and coarse aggregate samples as prescribed in IM 301.

The Contractor is required to furnish, at the proportioning plant site, facilities for collecting representative samples of the coarse aggregate from a ribbon or stream. Refer to Article 2001.20. Do not attempt to secure samples in dangerous locations. Under no circumstance should samples be secured from a partially opened clam bucket or from the discharge end of a belt where proper walkways and stairs do not exist. Refer to Article 2001.06.

Secure and test aggregate samples at least as frequently as described in IM 204.

b. GRADATION. Determine the fine and coarse aggregate sieve analysis in accordance with IMs 302 and 306. These Instructional Memorandums prescribe the test sample size and the procedures for fine and coarse aggregate sieve analysis and for determining the amount of material finer than the No. 200 (75 µm) sieve. Sample calculations are included.

Article 4109 of the Standard Specifications allows an increase of the minus No. 200 (75 µm) material from 1.5% to 2.5% with certain restrictions. Determination to allow this increase shall be made by consultation with the District Materials Engineer.

For projects requiring certified plant inspection, the certified inspector results shall be quality control tests. Quality control testing is performed to ensure the proper material is being delivered to the plant from the source and identify stockpile changes. Verification sampling and testing will be performed by the Engineer at the frequency described below. IM 205 describes the agency responsibility to randomly select sample location and time, and witness sampling with the contractor providing assistance in obtaining the samples.

For continuous construction operation, a verification lot is defined as a week of paving. Lots less than three days of paving will be grouped with the previous or subsequent lot. A verification lot may include a minimum of three days up to eight days. Quality control sampling and testing shall be performed daily. Verification sampling and testing will be performed the first day of paving. Thereafter, verification sampling will be performed daily and tested once per lot. If production on a given day is less than 250 cubic yards, verification sampling may be grouped with the previous or subsequent full day of paving.

Intermittent construction operation involving small quantities, less than 250 cubic yards per day, shall be grouped to establish a lot not to exceed one week. A minimum of one quality control sample shall be obtained and tested during the week. A minimum of one verification sample will be obtained and tested during the week.

When a quality control gradation test does not comply with the gradation requirements of Article 4109, the certified plant inspector shall contact the Engineer. After corrections have been made, the Engineer will obtain and test another verification sample.

When a verification gradation test does not comply with the gradation requirements of Article 4109, the Engineer will contact the contractor and the District Materials Engineer. The District Materials Engineer may investigate sampling and testing procedures, stockpiling, source material, etc. After corrections have been made, the Engineer will obtain and test another verification sample.

A lot is accepted when a verification test result by the Contracting Authority is determined to be in compliance. The Engineer will retain the samples until the lot is accepted. The Contractor may elect to run a split sample when the verification samples are obtained. The Engineer will witness the splitting and secure their portion of the sample. Since the contracting authority tests are verification, correlation with IM 216 is not required, but may be performed as a check of sampling and testing procedures only.

c. SPECIFIC GRAVITY. Determine in accordance with IM 307 and IM 308. The W-W_1 chart, IM T215A, which shows the corresponding moisture content values, is also included. It must be noted that the mass of the sample for determining both W and W_1 must be 1000 to 2000 grams respectively for the fine and coarse aggregate for the W-W_1 chart to be valid.

Minimum testing will be one sample per day for both coarse and fine aggregates for the first three days of normal operation and one for each three days of normal operation for both coarse and fine thereafter, assuming the first three days' results are consistent.

The specific gravity should not vary more than 0.02 from the tabular value (T203-General Aggregate Source Information) or from one day's test to the next. If the above variations are greater then 0.02, inform the Engineer and the District Materials Engineer immediately. The District Materials Engineer may adjust the specific gravity used to determine batch weights.

d. MOISTURE. Tables T214A, showing the Moisture Reciprocals (multiplication factors) that can be used for adjusting the aggregate batch amounts for the moisture content are included. The method most preferred for adjusting batch amounts is located in the Proportions section of this instruction.

Document all original test result information in the field book or other permanent records. Record the following for each test:

- All W and W_1 determinations
- The mass retained on each sieve for gradation
- All calculations for arriving at the final test result, i.e., moisture and gradation

The Specifications (Article 2301.13A) provide that coarse aggregate with absorption of 0.5% or more shall be wetted in the stockpile or cars, and methods of handling shall be such that change in moisture content in excess of 0.5% between successive batches must be prevented.

The use of materials that have varying amounts of moisture shall not be permitted. When the moisture content varies more than one-half percent from one batch to the next, the material must not be used unless something can be done to make the moisture uniform. It is the responsibility of the plant operator to devise remedial measures.

When the moisture content in either aggregate is high enough that water can be observed dripping from the bin between batches, or when the water will drip from the sample as described in Article 2301.13A3, the moisture cannot be measured successfully with the pycnometer nor can it be uniformly controlled. Materials with too much free water as described above must not be used until the moisture content has stabilized. It is the plant inspector's responsibility to recognize when this condition occurs and to secure the necessary corrective measures. Close communication with the grade inspector will inform the plant inspector when difficulties caused by moisture variation arise. When proportioning equipment is equipped with features, which allow instantaneous moisture content measurement of an aggregate, the following shall apply:

1. The acceptance of this system will be based on a correlation of the aggregate moisture content in a batch as determined by the proposed system and the moisture content determined by tests described in IM 308. The proposed system should be able to accurately determine the moisture content within 0.5 percent when compared to a sample obtained from a point in the plant as close as possible to the point of measurement used by the proposed system.

2. Prior to project startup, the contractor shall provide the engineer with the current calibration range data for the proposed system. The calibration range shall be used to establish the upper and lower limits of the range. After plant calibration, a check between the moisture content obtained by the system and the moisture content determined the test described in IM 308 shall be made prior to production.

3. Batch weights for the aggregates proportioned using this proposed system may be adjusted automatically on an individual batch basis. Moisture content results outside the upper and lower range limits of system shall not be used to adjust batch weights.

4. The limit in moisture content variation between successive batches will not apply. (Ref. Standard Specification Article 2301.13A3 and IM 527)

5. Moisture contents determined by the test described in IM 308 shall be performed at the frequency prescribed in IM 204 to establish correlation with results from the moisture determination system as per Paragraph 1. After correlation is demonstrated, the Engineer may reduce the frequency of moisture testing (IM 308) to a minimum of once per week for verification of the system.

6. The proposed system will provide a batch by batch record of the material weights, percent of moisture of the aggregates, time, date, batch number, truck number, mix type, water in aggregate, total water in batch and end tares for all scales and meters. This may be in the form of a printed summary report or as a ticket to be sent to the project, provided the ticket includes the required information as shown on Form #830212 and described in IM 527.

2. STRENGTH

Test specimens shall be cast, cured, and tested as per the appropriate IM (i.e., IM 315, IM 316, and IM 328).

PROPORTIONS

The following procedure is required for determining basic proportions of dry materials in order that the proportions used in the work are correct:

1. The Contractor representative must make the calculations necessary to determine the quantities of dry ingredients and water necessary to comply with the mix proportions specified.

2. Before the plant operation begins or resumes the plant inspector (if certified plant inspection does not apply) or the monitor inspector will independently determine the batch quantities and cross check them with those made by the contractor representative.

3. Batching operations shall not commence until both independent determinations have been made and documented in the field records.

The proportions in the Standard Specifications are stated in terms of absolute volume per unit volume of freshly mixed concrete. Refer to IM 529. To obtain the weight (mass) of aggregate or cement per batch, the specified absolute volume per unit volume must be multiplied by the number of cubic feet (cubic meters) of concrete per batch, and this product multiplied by the mass of saturated surface dry aggregate or dry cement per cubic foot (cubic meter). The weight (mass) per cubic foot (cubic meter) of aggregate will be determined using the aggregate specific gravities shown in Table T203, General Aggregate Source Information.

Table T203 is revised annually, and care must be taken to use the table, which is current. Follow the same procedure for determining the cement batch weight. However, the specific gravity for Type 1 Portland Cement is constant for all brands at 3.14 (3.17 for Type III).

The following is an example of a basic mix without fly ash.

Determine the mass of the cement and aggregate batch for a C-3 mix using crushed stone from B.L. Anderson's Montour Quarry and sand from Manatt's at Tama.

abs. vol. x kilograms of water/cubic meter x sp.gr. = kilograms/cubic meter
(abs. vol. x cubic feet/cubic yard x sp.gr. x lbs. of water/cubic foot = lbs./cubic yard)

Cement - specific gravity 3.14
Specified unit absolute volume, From IM 529, 0.114.

(0.114) (1000) (3.14) = 358 kilograms
[(0.114) (27) (3.14) (62.4) = 603 lbs.]

Fine aggregate - specific gravity 2.66
Specified unit absolute volume, from IM 529, 0.302.

(0.302) (1000) (2.66) = 803 kilograms
[(0.302) (27) (2.66) (62.4) = 1353 lbs.]

Coarse aggregate - specific gravity 2.63
Specified unit absolute volume, From IM 529, 0.370.
(0.370) (1000) (2.63) = 973 kilograms
[(0.370) (27) (2.63) (62.4) = 1639 lbs.]

The above masses are for one cubic yard (cubic meter) of concrete and would have to be multiplied times the total cubic yards (cubic meters) being batched.

The Batch Tables contain the masses of the batch including cement predetermined for the respective mixes using the above calculation procedure. These aggregate amounts must be corrected for the amount of moisture determined by the pycnometer method. While the plant inspector is instructed to make specific gravity determinations in the field, these determinations are for the cross checking the tabular value and must not be used for batch calculations. THE SPECIFIC GRAVITY VALUES FURNISHED IN THE CURRENT TABLE T203, AGGREGATE SOURCE INFORMATION, MUST BE USED FOR CALCULATING THE DRY BATCH.

1. ADJUSTMENTS FOR MINERAL ADMIXTURE SUBSTITUTION & CEMENT MODIFICATION

Fly ash or GGBFS may be substituted for cement at the contractor's option within certain restrictions. Article 2301.04 specifies the substitution rates as they relate to time of the year.

IM 529 lists each standard concrete mix. These mixes contain only cement but may be adjusted to accommodate fly ash or GGBFS substitution. Explanation of how those adjustments are to be performed is discussed later. The procedure to make necessary adjustments for increasing cement content in a mix is also explained later in the IM.

2. PROPORTIONING A MIX FOR A MINERAL ADMIXTURE SUBSTITUTION

a. To adjust a standard mix for fly ash or GGBFS substitution, the amount of cement specified for a basic mix is multiplied by the percentage of fly ash that is to be substituted. This product will give the kilograms (pounds) of fly ash in the mix. To calculate the adjusted cement in the mix, subtract the fly ash or GGBFS amount from the basic cement weight (mass). The basic water must also be adjusted. This is done by taking the design w/c, which is found in IM 529, and multiplying that number by the total amount of cementitious material in the mix. The product of that calculation will be the adjusted kilograms (pounds) of basic water.

b. The absolute volumes must also be adjusted for the new mix. This is done by multiplying the specific gravity of the material by the kilograms of water per cubic meter or 1000 (pounds of water per cubic yard times cubic feet in a cubic yard or 62.4 x 27), then dividing the kilograms per cubic meter (pounds per cubic yard) by that amount. This procedure is used for the cement, fly ash, GGBFS, and water. Those absolute volumes plus the absolute volume of air, which is designated as 0.060, must be summed and subtracted from 1.000. The remaining volume is the aggregate portion of the mix.

c. To determine the volumes of the coarse and fine aggregate, the number from the difference above would be multiplied by the percentage of each aggregate used in the mix. The percentage would depend on the mix number being used, for example, a C-4 mix would have 50% coarse aggregate and 50% fine aggregate, a C-3 mix would have 55% coarse aggregate and 45% fine aggregate. After the absolute volumes of the fine and coarse aggregate are determined, the kilograms of each shall be determined. This is done by multiplying the absolute volumes of the aggregate by the specific gravity of that aggregate and by kilograms of water in a cubic meter (pounds of water in a cubic foot x cubic feet in a cubic yard).

Example A, in Appendix B, shows the process of adjusting a mix for 15% fly ash usage in a C-mix using the form provided.

3. PROPORTIONING A MIX FOR ADDITIONAL CEMENT

Adjusting a mix for additional cement would be accomplished by the same procedure as above. To find the basic cement the formula on page 18 would be used. To add 15% more cement in the mix, the basic cement would be multiplied by 115%. This figure is the adjusted cement in kilograms (pounds). The rest of the procedure would be identical to the procedure used for the addition of fly ash to a mix.

The above dry aggregate batch amounts must be adjusted to account for moisture or lack of moisture in the aggregates. If additional moisture is present above the amount for the saturated and surface-dry condition (SSD), refer to IM 308. The aggregate dry batch amount must be increased an amount equal to the mass of the water in the aggregate batch. If aggregates have less moisture than is present for the SSD condition, the aggregate dry batch amount must be reduced an amount equal to the mass of the water in the batch, below what is required for the SSD condition. When the latter condition occurs, the aggregate is described as having absorption. It occurs infrequently and for short duration and will generally be found during or at the end of a prolonged hot dry period in mid or late summer. The maximum permissible absorption limit is 0.5 percent. If the absorption exceeds 0.5 percent refer to the section entitled, "General" in this IM for the special action necessary.

The District Materials Engineer must authorize proportion adjustments (changing material amounts), if any are necessary.

There are two procedures that can be used for adjusting the dry aggregate batch amount to account for the free moisture in the aggregates. If a system with instantaneous moisture content measurement equipment is used to automatically adjust individual batch weights, see previous section, **Sampling & Testing/Moisture,** for instructions on an approval, use, and monitoring of the system.

The following example illustrates one of the methods used:

Assume the fine aggregate contains 3.4 percent and the coarse aggregate contains 0.7 percent of free moisture.

Fine aggregate -- 100.0 percent minus 3.4 percent = 96.6 percent
803 ÷ 96.6 x 100 = 831 kilograms (1353 ÷ 96.6 x 100 = 1401 lbs.)

Coarse aggregate -- 100.0 percent minus .7 percent = 99.3 percent
973 ÷ 99.3 x 100 = 980 kilograms (1639 ÷ 99.3 x 100 = 1651 lbs.)

To determine the free water in the aggregates subtract the dry aggregate quantity from the adjusted dry aggregate weight for both aggregates and add the two differences.

831 kg - 803 kg = 28 kg (1401 lbs. - 1353 lbs. = 48 lbs.)
980 kg - 973 kg = 7 kg (1651 lbs. - 1639 lbs. = 12 lbs.)

28 kg + 7 kg = 35 kg (48 lbs. + 12 lbs. = 60 lbs.) of free moisture in one cubic yard (cubic meter) of concrete.

The less preferred method is to use the moisture reciprocal tables T214A in which the correction factors are for 3.4 and 0.7, 1.0351967 and 1.0070493 respectively. Multiply the dry aggregate batch weight determined previously by the respective moisture reciprocal correction factor.

Fine aggregate (803 kg)(1.0351967) = 831 kg [(1353 lbs.) (1.0351967) = 1401 lbs.]

Coarse aggregate (973 kg)(1.0070493) = 980 kg [(1639 lbs.) (1.0070493) = 1651 lbs.]

These adjusted quantities are for one cubic meter (cubic yard) and would have to be multiplied times the total cubic meters (cubic yards) being batched. To determine the free water in the aggregates, subtract the dry aggregate weight from the adjusted dry aggregate amount for both aggregates and add the two differences as you did above in the example.

Add the total free water in the aggregates to the water proportioned into the mixer to determine the total water for mixing. The **aggregate moisture tests** shall be determined and recorded at a minimum of **one test per each half day** of operation. Determine and record also at the same time the adjusted dry aggregate batch amounts, the water in the materials, the water proportioned and the total water available in the batch for mixing.

Consult with your District Materials Engineer office staff that will provide a print out of the batch amounts for varying moisture contents.

Record in the plant field book all weight determinations and calculations and sign each day's entry.

Check the aggregate scale settings, also at three-hour minimum intervals, as indicated by the adjusted dry aggregate batch weights. Refer to the section entitled Equipment, in this IM, for the procedure to follow when scale adjustments are required.

The water demand of a particular mix is dependent upon the materials used in the mix. For this reason the water batch weight is determined by trial when the mixing begins. The water batch weight is controlled indirectly by the slump requirements.

Many central mixing plants have equipment for introducing additional water into the mixer after the batch has been in the mixer and has been mixed. The additional water is added manually through a system, which is independent from the main water proportioning system. The auxiliary water meter must be read at the same interval as the moisture determinations and scale adjustments are made. The total water through the auxiliary system is reduced to the pounds per batch basis by dividing by the number of batches produced during the three hour interval and the per batch amount must be included in the total mixing water recorded per batch.

The plant inspector must keep a record in the plant field book of the total mixing water used, including the water in the aggregates, for at least each three (3) hours of normal operation to determine that the maximum permissible water content is not exceeded and to determine the batch volume.

Whenever the water demand, to achieve the desired workability, exceeds the design water/cement ratio and approaches the maximum water allowed, the Engineer and the District Materials Engineer Office should be notified. At the same time, aggregate moisture contents, batch weights, cement scales, water meter, etc., should all be immediately checked. In no circumstance should the maximum water/cement ratio be knowingly exceeded.

If, after the District Materials Engineer investigation and evaluation, additional workability above that which is attainable with the maximum permissible water content is desired, the cement content may be increased in accordance with Article 2301.04B. This should be done only with the approval of the District Materials Engineer or his/her representative. The District Materials Engineer will provide the revised and adjusted mix proportions for these situations.

If the batch yield variation is less than 98 percent or greater than 102 percent for the water content being used, refer to Specification Article 2301.04B for the special action necessary. The District Materials Engineer may allow adjustments in the proportions after checking moisture contents of the material and the operation of the batching equipment.

Mixes using fly ash as a substitution for cement are permitted as a contractor option, as allowed in the specifications.

OTHER REPORTED TESTING

1. IN-PLACE AIR CONTENT

   a. Air content of vibrated, in-place concrete shall be checked in accordance with Article 2301.04, Paragraph C.

   b. A concrete sample shall be taken from the in-place slab in accordance with IM 327.

   c. There are no acceptance/rejection criteria for these tests. They are for information purposes. The tests are intended to be used to measure air loss through the paver and consistency of the air content of the in-place concrete. The tests should be used to determine the target air content in front of the paver and if corrective action is needed. A test result less than 5.0% would indicate that action needs to be taken. Reducing vibrator speed including repositioning vibrators to accommodate additional vibrators should be considered if a small increase in the addition rate of air entraining agent is not sufficient to raise the in-place concrete air content.

      If these efforts do not solve an air loss problem, the engineer and District Materials Engineer shall be consulted.

2. VIBRATION CHECKING

   In accordance with Article 2301.07, an electronic vibrator-monitoring device displaying the operating frequency of each individual internal vibrator is required for all Interstate and Primary paving over 50,000 square yards (40,000 m^2).

   a. The vibration speed of each internal vibrator of a slip form paver shall be checked a minimum of once per day. These tests shall be performed while the paver is in operation and concrete surrounds the vibrators.

   b. If any vibrator is found to be operating outside the limits of the specification, the vibration speed shall be immediately changed to comply with the specification. If any vibrator cannot be adjusted to operate within the specification, the paving operation shall be stopped until corrections are completed.

   c. The vibration speeds for each vibrator shall be recorded in the project records. When a vibrator is found to be operating outside the specification limits, record the vibrator speed, location of the vibrator across the pavement, and approximate beginning and ending stations of the section of pavement affected if it can be determined.

REPORTS & REPORTING

1. PLANT PAGE – FORM #240

   Plant reports are to be recorded in the computer program or on hand completed forms, both provided by the Iowa Department of Transportation. A copy of the completed PCC Plant Page shall be faxed or delivered to the District Materials Engineer on the next working day, within four hours after start-up of the plant. The CPI shall keep a copy of the PCC Plant Page and send the original to the Engineer. Copies of the files containing the project information are to be available to the engineer upon request until the project is final.

A separate report is to be made for each day concrete is placed. These reports are to be consecutively numbered for each project. A sample copy and the instructions on completing this report are in Appendix A.

When computer forms are used the CPI and Monitor shall indicate their review by marking initials by their printed name.

2. PERSONAL COMPUTER

The personal computer shall be capable of running Microsoft Excel 97 or newer version to use Iowa DOT Programs. The printer shall be capable of producing quality hard copies. That is, original printed output, which is clearly readable and remains readable after being faxed and/or copied.

3. READY MIXED CONCRETE, TRUCK TICKET FORM - FORM #830212

When concrete source for a paving project is a commercial ready mix plant, each truckload of concrete must be identified by Form #830212 or acceptable computer generated plant ticket.

The plant inspector or the scale operator must fill in the information pertaining to the plant, and the grade inspector must collect and record the information pertaining to the grade, assemble the tickets by day and store with the other project records. These completed tickets will contain primary information and must not be lost or destroyed. A sample is shown in Appendix C.

4. PORTLAND CEMENT SHIPMENT YIELD REPORT - FORM #820912

The cement shipment yield test is described in section 2a, Cement Scales. Report the cement yield results on Form #820912. A sample copy of Form #820912 is included in Appendix C.

IMs & SPECIFICATIONS

A list of the IMs and Specifications used in PCC Plant Inspection are located at the end of this IM.

CONCRETE PLANT INSPECTION CHECKLIST

A. The proportioning equipment must be examined at least at 3-hour intervals for correctness of the amount being delivered and for damage.

B. The scale sensitivity shall be checked at least twice during a normal working day by placing a mass equal to 1/10 percent of the batch on the fully-loaded scales and observing the movement of the indicator.

C. Check scale operation to determine cement delivery tolerance conformance at least once during each day of normal operation.

D. The Standard Specification requires that the cement shipment yield determination must be made at intervals of approximately 10,000 cubic yards (10,000 cubic meters) after the original determination made near the end of the first full day of production.

E. Check scale operation to determine aggregate delivery tolerance conformance at least once during a normal working day and document.

F. If water is measured with a scale, the delivery tolerance must be determined at least once for each day of normal operation and document.

G. Admixture dispensers shall be observed for uniform delivery at least once during each 3 hours of normal operation and document.

H. Admixture dispensers must be flushed with water at least once daily.

I. Determine and record the mixing speed and the mixing time at least once daily by using the sweep hand of a watch and counting the drum revolutions in one minute.

J. Determine and record the time between batching and placement at least once during each day of normal operation.

K. Specific gravity - One sample per day for both coarse and fine aggregates for the first three days of normal operation and one for each three days of normal operation for both coarse and fine thereafter, assuming the first three days results are consistent.

L. Moisture - A minimum of one test per each half day of operation.

M. Gradation - Obtain and test one sample per day. Show sample number, name of sampler, and name of tester on lab work sheet.

N. If opening not determined by maturity method, cast one 20-in. (508-mm) long beam for each 2000 cu. yd. (1529 cubic meters) of concrete placed. Make flexural tests representing alternating 2000 cu. yd. (1529 cubic meters) placement units at 7 and 14 days.

O. At the plant, the plant inspector shall remove the specimens, clean the molds, oil and return the molds to the grade at the direction of the paving inspector. The plant inspector shall store the specimens until date of test. The storage space shall be a pit adequate for the project, and for normal projects it should be at least 4 ft. x 6 ft. x 18 in. (1.2 m x 1.8 m x .46 m). The specimens shall be wet at all times. If the temperature in the sand filled pit drops below 40°F (4.4°C), remove the specimens and place them under wetted burlap in a heated enclosure or in lime-saturated water. See IM 328. **NOTE:** Lime-saturated water is prepared by mixing 1 ounce (30 ml) of hydrated lime with 1 gallon (4 L) of water.

P. When opening is determined by the maturity method, casting beams every 2000 cubic yards (1529 cubic meters) is not required. The plant inspector should ensure curve development is performed according to IM 383.

Q. Other duties include:

- Close observation of stockpiling and handling of aggregates. There must be no intermingling of aggregates and no contamination.
- Frequent check on wet batch or dry batch truck cleanliness and degree of discharge.
- Document all the above data in diary.

- Make the following report daily: Plant Reports - Form #800240
- Make the following report as prescribed: Cement Yield Report - Form #820912E
- At the end of the project, make a copy of the plant book for the Engineer. When required by Article 2301.07, make a copy of vibration-monitoring device records in electronic format.

IMs/SPECIFICATIONS USED IN PCC PLANT INSPECTION BY VOLUME

Volume II IMs:

IM 527	Paving Plant Inspection
IM 528	Structural Concrete Plant Inspection
IM 529	Portland Cement (PC) Concrete Proportions
IM 401	Hydraulic Cements
IM 403	Chemical Admixtures for Concrete
IM 491.14	Ground Granulated Blast Furnace Slag (GGBFS)
IM 491.17	Fly Ash
IM 203	Consultation Provided by Materials Personnel on Construction Projects
IM 204	Inspection of Construction Project Sampling & Testing
IM 213	Technical Training & Certification Program
IM 216	Guidelines for Validating Testing Results
IM 301	Aggregate Sampling & Minimum Size of Samples for Sieve Analysis
IM 302	Sieve Analysis of Aggregate
IM 306	Determining Amount of Material Finer than the No. 200 (75 µm) Sieve in Aggregate
IM 307	Determining Specific Gravity of Aggregate
IM 308	Determining Free Moisture & Absorption of Aggregates
IM 316	Flexural Strength of Concrete
IM 317	Slump of Hydraulic Cement Concrete
IM 318	Air Content of Freshly Mixed Concrete by Pressure
IM 327	Sampling Freshly Mixed Concrete
IM 328	Making, Protecting & Curing Concrete Flexural Strength Field Specimens
IM 383	Testing Strength of Portland Cement Concrete Using the Maturity Method

Volume IV IMs:

IM 209	Certified Aggregates & Approved Producer Program
IM 409	Source Approvals for Aggregates
IM T203	General Aggregate Source Information

Specifications:

2301	Portland Cement Concrete Pavement
2403	Structural Concrete
4100	General Provisions
2001	General Equipment Requirements

Supplemental Specifications:

The Supplemental Specification that was in effect at the time of the project letting will be used.

INSTRUCTIONS FOR COMPLETION OF PCC PAVING & STRUCTURAL REPORTS

The new reporting process does not include Mobile Mixer information. Use the following forms and reports when using a Mobile Mixer:

Form M or E 115	Air & Slump Record
Form M or E 120	Mobile Mixer Data Record
Report #820180	Gradation Test
Report #821297	Nuclear Density of Plastic PC Concrete
Report #820020	Mobile Mixer Calibration

Project No.

Enter the project number listed on the plans.

Plant Name

Enter the name of the ready mix plant and location for structural concrete. Enter the approximate location of a paving plant set up by a contractor.

Example: Croell - Waverly (Ready Mix)
2 miles NW of Waverly (Paving Plant)

Contractor/Sub

A group of people or a company must perform the work being done, either a prime or sub contractor. Enter the name of the contractor performing the work. If it is a subcontractor, list this after the contractor name.

Weather

Enter a brief description of the actual weather conditions at the paving plant. Weather conditions are not required for structural concrete (Ready Mix).

Contract ID

Enter the nine-digit contract number listed at the top of a contract. This is not the five-digit accounting ID number listed with the project number.

County

Enter the county listed on the project plans.

Temperatures, Min. & Max.

An air temperature shall be recorded early in the morning for the minimum and around mid-afternoon for the maximum. Take the temperatures in a shaded area, otherwise they are meaningless. Temperatures are not required for structural concrete (Ready Mix).

Report No.
Start with the number 1 at the beginning of work for each item on each project. The ending report number shall coincide with the last day each item is completed for paving and the last week for structural. Do not restart the report sequence if the project carries over to the next year.

Example:	(Paving)	16 days of 200-mm slip form paving - report 1 through 16.
	(Ready Mix)	8 weeks of concrete on Des. 1290 - report 1 through 8.

Date This Report
Enter the date the concrete is placed for each day of paving. Enter the last day of the workweek for structures (normally the Saturday date).

Date of Last Report
Self-explanatory.

Design No.
Enter the design number of the structure where the concrete is being placed on each project. Leave this space blank on paving projects.

Check Mix (Central or Ready)
Place an "X" in the appropriate box provided indicating how the concrete is being produced.

Check Usage (Paving, Structural, Incidental, Patching)
Place an "X" in the appropriate box provided to indicate the type of work where the concrete is used.

Date (Mo./Day)
This column is only used for Ready Mix concrete applications. Enter the month and the date for each day of production during the week.

Example: 5/24, 7/01, 12/03, etc.

Mix Number
Enter the mix number being used that is listed in the proportion tables of IM 529.

Station (Beg./End/Dir)
Enter the beginning and ending station for concrete placed daily by mix. Enter the direction (N, S, E, W) for divided sections or B for 2-lane sections.

Batched
Enter the total cu. yds. (m^3) batched for each mix for a paving plant. Enter the total cu. yds. (m^3) batched for each unit poured for structures.

% Of Est. Used
Enter the percent of estimated concrete used.

Fine, Intermediate & Coarse Aggregate (Moisture)
Enter the percent moisture once in the morning and once in the afternoon for paving projects. Enter

the percent moisture for each unit poured on structures.

Fine, Intermediate & Coarse Aggregate (T203 sp gr)

Enter the specific gravity for each aggregate listed in the T203 source tables.

Fine, Intermediate & Coarse Aggregate (Dry Mass or Wt.)

Enter the weight (mass) of each aggregate calculated by absolute volumes.

Actual Quantities Used Per cu. yds. (m^3) in Kilograms (Pounds)

Cement	Enter the pounds (kilograms) of cement calculated by absolute volumes.
Fly Ash	Enter the pounds (kilograms) of fly ash calculated by absolute volumes.
GGBFS	Enter the pounds (kilograms) of ggbfs calculated by absolute volumes.
Fine	Enter the actual pounds (kilograms) of fine aggregate adjusted by moisture content.
Inter.	Enter the actual pounds (kilograms) of intermediate aggregate adjusted by moisture content.
Coarse	Enter the actual pounds (kilograms) of coarse aggregate adjusted by moisture content.
In Agg.	Enter the calculated difference between the actual weights (masses) and the dry weights (masses) of both fine and coarse aggregates.
Plant	Enter the average pounds (kilograms) of water added at the plant for each cu. yd. (m^3).
Grade	Enter the average pounds (kilograms) of water added on the grade (when permitted by specification).

Avg. W/C Ratio

Enter the ratio of total water in one cu. yd. (m^3) divided by the total sum of cement and fly ash in one cu. yd. (m^3), report to three decimal places.

CPI Gradations

This section of the report is for reporting the Certified Plant Inspector gradation test results for the coarse and fine aggregates being used in the mix. If one of the tests fail and backups are tested, record the average in the column provided, which is located just right of the specifications column.

Batched (Today or Week)

Place an "X" under the Today column if the report is being submitted daily (paving).
Place an "X" under the Week column if the report is being submitted weekly (structures).

Concrete Batched

Enter the total cu. yd. (m^3) of concrete batched under the appropriate column. Paving plant totals are normally under the Today column; structural concrete totals are normally under the Week column.

To Date Total

Enter the running total for both concrete and cement.

Air Entraining (Air Ent.)

Enter the brand name or source, average rate per cu. yd. (m^3), and lot number.

Water Reducer (Wat. Red.)

Enter the brand name or source, average dosage rate, and lot number.

Retarder
Enter the brand name or source, average dosage rate, and lot number.

Calcium Chloride (Cal. Chlor.)
Enter the brand name or source, average dosage rate, and lot number only when added at the plant site.

Superplasticizer (Superplas.)
Enter the brand name or source, average dosage rate, and lot number.

Concrete Treatment
Place an "X" directly behind Ice, Heated Water, or Heated Materials, if one or more are used. If ice is used to cool the mix, enter the pounds (kilograms) of ice per cu. yd. (m^3).

Cement
Enter the cement type, specific gravity, and source. See IM 401 for the actual source name.

Fly Ash
Enter the type and specific gravity and source. See IM 491.17 for the actual source name.

Example: Chillicothe and ISG Headwaters are not source names.
Ottumwa is the source name.

Rock
Enter the T203 A number, and gradation number.

GGBFS
Enter the grade, specific gravity, and source. See IM 491.14 for the actual source name.

Sand
Enter the T203 A number, and gradation number.

Intermediate
Enter the T203 A number.

Remarks
Enter delays, which may take place. Enter description of noncomplying test results.

CPI
Enter the Certified Plant Inspector name and certification number.

Monitor
Enter the plant monitor name and certification number.

If using the computer spreadsheet, most of this information will be entered on the Project Information and Mix Information sheets and automatically transferred to the Report. For QMC and BR mixes, the combined gradation will be calculated from aggregate percentages entered in the Mix Information Station From and To, Totals to Date Cement and Concrete, and Remarks will be entered directly on the Report.

The next page is an example of a completed Paving Plant Report.

800240E - 04/00 computer

Date of Placement		Location From	To
Mix 1	05/02/98	101+13	133+69
Mix 2	11/29/99		
Mix 3			
Mix 4			

Project No.: NHS-18-5(123)--19-17
Plant Name: CARLSON's HWY 65 & HWY 18
Contractor / Sub: FRED CARLSON
Weather: MOSTLY SUNNY

Contract ID: 17-0185-11
County: CERRO GORDO
Temp. (°F) Min: 48
Temp. (°F) Max: 70

Report No.: 2
Date This Report: 06/02/96
Date Of Last Report: 06/01/96

Check Mix(x)	
Central	X
Ready	

Check One(x)		SEND
Paving	X	(Daily)
Structure		(Weekly)
Incidental		(Weekly)
Patching		(Weekly)
		or end of Lot

	Mix	Batched (CY)	% Of Est. Used	Fine Aggregate Moist. (%)	Fine Aggregate T-203 Sp. G.	Fine Aggregate Wt. SSD (lbs)	Intermediate Aggregate Moist. (%)	Intermediate Aggregate T-203 Sp. G.	Intermediate Aggregate Wt. SSD (lbs)	Coarse Aggregate Moist. (%)	Coarse Aggregate T-203 Sp. G.	Coarse Aggregate Wt. SSD (lbs)	Actual Quantities Used Per cy (in pounds) Cement	Fly Ash	GGBFS	Fine	Inter.	Coarse	Water In Agg.	Water Plant	Water Grade	Avg w/c Ratio	Max w/c Ratio
1	C-3WR-C15	1,100.00	101.3	4.0	2.67	1,390				0.9	2.75	1,751	470	83		1,448		1,767	74	164.0		0.430	0.489
2																							
3																							
4																							

Coarse	1 1/2"	1"	3/4"	1/2"	3/8"	#4	#8	#200	Comply
	100	50-100	30-100	20-75	5-55	0-10	0-5	0-1.5	Y/N
	100	75	49	31	14	4.1	0.5	0.5	Y

Concrete Treatment (x)		lb / cy
Ice		
Heated Water		
Heated Materials		

Batched			
Check One (X)	Today X	Week	Total To Date
Concrete (CY):	1,100.00		17,279.60
Cement (tons):	258.50		5,007.39

Inter.	1 1/2"	1"	3/4"	1/2"	3/8"	#4	#8	#200	Comply
									Y/N
									NA
									NA
									NA

	Brand / Source	Rate	Lot Number
Air Entraining:	SIKA AEA 15	7 OZ./CY	C80005M
Water Reducer:	SIKA PLASTOCRETE 161	3 OZ./CWT	D80002P
Retarder:			
Calcium Chloride:			
Superplasticizer:			

Fine	3/8"	#4	#8	#16	#30	#50	#100	#200	Comply
	100	90-100	70-100		10-60			0-1.5	Y/N
	100	88	69	44	25	11	4.7	0.3	Y

	Type	Sp. Gr.	Source
Cement:	IS	3.04	HOLNAM
Fly Ash:	C	2.56	PORTAGE 1
GGBFS:			

Adjusted % Passing Calculated Combined Gradation

	1.5"	1"	3/4"	1/2"	3/8"	#4	#8	#16	#30	#50	#100	#200	Within Target
Target													

	T-203 A - #	Grad No.
Coarse:	A17008	4
Intermediate:		▨
Fine:	A17514	1

Remarks
This is a test report

C.P.I.: JEFFREY BOLSINGER NE118
Monitor: JASON RUTER NE443

Distribution: ____ Central Materials ____ DME ____ Proj. Eng. ____ Plant

EXAMPLE A

Rev 02/01

Iowa Department Of Transportation
Office Of Materials
PORTLAND CEMENT CONCRETE

Form E820150E

Project No.: F-273(26)10
County : BUCHANAN

Mix No.: C-4WR-C15
Pounds Cement: 593

1st Adjusted lbs. Cement: 504 **Source:** MONARCH I **Sp. Gr.:** 3.14
IM 491.17 Fly Ash: 89 **Source:** LOUISA **Sp. Gr.:** 2.68
IM 491.14 Slag GGBFS: ______ **Source:** ______ **Sp. Gr.:** ______

2nd Adjusted lbs. Cement: 504
Total Cementitious 593

IM T203 Fine Aggregate Source: NIEMAN CONST. HUFFMAN **Sp. Gr.:** 2.65
IM T203 Interm. Aggregate Source: ______ **Sp. Gr.:** ______
IM T203 Coarse Agregate Source: NIEMAN CONST. JESSSUP **Sp. Gr.:** 2.63

Basic w/c 0.430 **Water (lbs/cy) = Design w/c (wt. cement + wt Fly Ash +Slag) =** 255
Max w/c 0.489 **Max. Water (lbs/cy) = Design w/c (wt. cement + wt Fly Ash +Slag) =** 290

Absolute Volumes	**Cement**	**(lbs/cy) / (Sp. Gr. X 62.4 X 27)**	**=**	**0.095**
	Fly Ash	**(lbs/cy) / (Sp. Gr. X 62.4 X 27)**	**=**	**0.020**
	Slag	**(lbs/cy) / (Sp. Gr. X 62.4 X 27)**	**=**	
	Water	**(lbs/cy) / (1.00 X 62.4 X 27)**	**=**	**0.151**
	Air			**0.060**
		Subtotal	**=**	**0.326**
		1.000 - Subtotal	**=**	**0.674**
		Total	**=**	**1.000**

% FA Agg.:	50	**Fine Aggregate (1.000 - Subtotal) X % In Mix**	**=**	**0.337**
% In. Agg.:		**Interm. Aggregate (1.000 - Subtotal) X % In Mix**	**=**	
% CA Agg.:	50	**Coarse Aggregate (1.000 - Subtotal) X % In Mix**	**=**	**0.337**
		Aggregate Total	**=**	**0.674**

Aggregate Weights	**Fine Aggregate (abs vol.) X Sp. Gr. X 62.4 X 27**	**=**	**1505**
	Intermediate Aggregate (abs vol.) X Sp. Gr. X 62.4 X 27	**=**	
	Coarse Aggregate (abs vol.) X Sp. Gr. X 62.4 X 27	**=**	**1493**

Summary

Cement	504	**(lbs/cy)**
Fly Ash	89	**(lbs/cy)**
Slag		**(lbs/cy)**
Water	255	**(lbs/cy)**
Fine Agg.	1505	**(lbs/cy)**
Interm. Agg.		**(lbs/cy)**
Coarse Agg.	1493	**(lbs/cy)**

Distribution: ___ **Materials,** ___ **DME,** ___ **Proj. Engr.,** ___ **Contractor**

Form 830212
10-95

READY MIX CONCRETE

______________________________ Plant

Truck No. ______________ Ticket No. ______________

Date ______________ Des. No. ______________

Proj. No. ______________________________

Mix No. ______________ Retarder/Water Reducer? ☐ Yes ☐ No

Conc. This Truck ______________________ C.Y./m³

Air agent added this truck ______________________ oz./mL

Time Batched ______________ Discharged ______________

Rev. Mixed *(Plant)* ______________ Grade ______________

Water *(gal./L or lbs./kg This Truck)* 8.33lbs./gal.

In Aggregate __________ gal./L __________ lbs./kg
Added *(Plant)* __________ gal./L __________ lbs./kg
Subtotal __________ gal./L __________ lbs./kg
Added Grade __________ gal./L __________ lbs./kg

TOTAL WATER __________ gal./L __________ lbs./kg

Maximum Water Allowed __________ gal./L __________ lbs./cy or kg/m³

Air ______________ Slump ______________

Plant Insp. ______________________________

Receiving Insp. ______________________________

Form 820912E - computer

Report No.: 1
Date Submitted: 01/02/04

Portland Cement Shipment Yield Report

Contract ID: 29999
Project No.: FM-85(25)--55-85
County: Story

Plant Location: NW Corr E29

Source: Ash Grove
Contractor: Manatt's

Date	Invoice Number	Billed Tons	Type	Date	Invoice Number	Billed Tons	Type	Date	Invoice Number	Billed Tons	Type
06/02/03	107312	28.19	I/II	06/04/03	107352	27.86	I/II	0	0	0.00	I/II
06/02/03	107313	28.14	I/II	06/04/03	107353	27.57	I/II	0	0	0.00	I/II
06/02/03	107314	27.85	I/II	06/04/03	107354	28.14	I/II	0	0	0.00	I/II
06/02/03	107315	27.81	I/II	06/04/03	107355	27.99	I/II	0	0	0.00	I/II
06/02/03	107316	27.92	I/II	06/04/03	107356	28.10	I/II	0	0	0.00	I/II
06/02/03	107317	28.21	I/II	06/04/03	107357	27.79	I/II	0	0	0.00	I/II
06/02/03	107318	25.49	I/II	06/04/03	107358	26.99	I/II	0	0	0.00	I/II
06/02/03	107319	26.57	I/II	06/04/03	107359	27.85	I/II	0	0	0.00	I/II
06/02/03	107320	28.06	I/II	06/04/03	107360	28.00	I/II	0	0	0.00	I/II
06/02/03	107321	28.02	I/II	06/04/03	107361	27.94	I/II	0	0	0.00	I/II
06/02/03	107322	28.15	I/II	06/04/03	107362	27.30	I/II	0	0	0.00	I/II
06/03/03	107323	28.36	I/II	06/04/03	107363	28.28	I/II	0	0	0.00	I/II
06/03/03	107324	28.08	I/II	06/04/03	107364	27.90	I/II	0	0	0.00	I/II
06/03/03	107325	27.73	I/II	06/04/03	107365	28.50	I/II	0	0	0.00	I/II
06/03/03	107326	28.26	I/II	06/04/03	107366	28.00	I/II	0	0	0.00	I/II
06/03/03	107327	25.55	I/II	06/04/03	107367	27.99	I/II	0	0	0.00	I/II
06/03/03	107328	28.19	I/II	0	0	0.00	I/II	0	0	0.00	I/II
06/03/03	107329	27.61	I/II	0	0	0.00	I/II	0	0	0.00	I/II
06/03/03	107330	28.18	I/II	0	0	0.00	I/II	0	0	0.00	I/II
06/03/03	107331	28.37	I/II	0	0	0.00	I/II	0	0	0.00	I/II
06/03/03	107332	28.24	I/II	0	0	0.00	I/II	0	0	0.00	I/II
06/03/03	107333	28.20	I/II	0	0	0.00	I/II	0	0	0.00	I/II
06/03/03	107334	28.03	I/II	0	0	0.00	I/II	0	0	0.00	I/II
06/03/03	107335	28.18	I/II	0	0	0.00	I/II	0	0	0.00	I/II
06/03/03	107336	28.03	I/II	0	0	0.00	I/II	0	0	0.00	I/II
06/03/03	107337	21.00	I/II	0	0	0.00	I/II	0	0	0.00	I/II
06/04/03	107338	27.78	I/II	0	0	0.00	I/II	0	0	0.00	I/II
06/04/03	107339	28.15	I/II	0	0	0.00	I/II	0	0	0.00	I/II
06/04/03	107340	28.25	I/II	0	0	0.00	I/II	0	0	0.00	I/II
06/04/03	107341	28.32	I/II	0	0	0.00	I/II	0	0	0.00	I/II
06/04/03	107342	27.89	I/II	0	0	0.00	I/II	0	0	0.00	I/II
06/04/03	107343	27.96	I/II	0	0	0.00	I/II	0	0	0.00	I/II
06/04/03	107344	28.50	I/II	0	0	0.00	I/II	0	0	0.00	I/II
06/04/03	107345	28.28	I/II	0	0	0.00	I/II	0	0	0.00	I/II
06/04/03	107346	27.27	I/II	0	0	0.00	I/II	0	0	0.00	I/II
06/04/03	107347	27.91	I/II	0	0	0.00	I/II	0	0	0.00	I/II
06/04/03	107348	28.34	I/II	0	0	0.00	I/II	0	0	0.00	I/II
06/04/03	107349	27.88	I/II	0	0	0.00	I/II	0	0	0.00	I/II
06/04/03	107350	28.34	I/II	0	0	0.00	I/II	0	0	0.00	I/II
06/04/03	107351	28.35	I/II	0	0	0.00	I/II	0	0	0.00	I/II

Mix No.	Cement Per CY (lbs)	Batched (CY)		Cement Batched (Tons)
C-4WR-C15	503	5,782.00	....	1,454.17
M-4	825	168.00	....	69.30
C-4WR	593	147.00	....	43.59
0	0	0.00	....	0.00
0	0	0.00	....	0.00
Left In		This Check (+)		1.53
Scale (Tons)		Previous Yield Check (-)		1.68
		Total Weighed (Batch Scale)		1,566.91

Total Billed Weight (Tons) 1,555.84

Yield = 100.7 %

C.P.I.: ____________________
Signature

Distribution: ____ DME ____ RCE ____ Central Materials ____ Contractor ____ Inspector

Form 820917
11-94

Iowa Department of Transportation

Office of Materials

PLANT CALIBRATION REPORT

☐ Portland Cement Paving Plant
☐ Ready Mix Plant

☐ Initial Calibration ☐ Check Calibration ☐ Change in Material Source

Shaded area to be completed for paving plants and when applicable for ready mixed concrete plants.

Contractor/Producer	County
Plant Location	**Project**
Class of Concrete	**Mix No.(s)**
Design W/C Ratio(s)	**Max W/C Ratio(s)**

MATERIAL	SOURCE Producer Name & Location	SPECIFIC GRAVITY	**DRY BATCH MASS**
Aggregate (Coarse)			
Aggregate (Find)			
Cement			
Fly Ash			
Water			
Air Entraining Agent			
Curing Compound			
Water Reducing Agent			
Retarding Admixture			

Calibrated by: ______________________ Title: ______________________ Date: __________

Coarse Aggregate Sampling Point: ______________________

Remarks: ______________________

Note: Circulation of air entraining, water reducing, and retarding admixtures is required **prior to** use.

This above data is furnished by the Contractor/Producer as set forth in the Standard Specifications for plant operations. The Contracting Authority makes no representations as to accuracy, either express or implied, which are to be construed to relieve the contractor from the responsibility to comply with the specifications.

Witnessed ______________________

Title ______________________

Distribution: White Copy - Plant Inspector; Canary Copy - Contractor/Producer; Pink Copy - Transportation Center Materials Engineer; Goldenrod Copy - Resident Engineer
Send copy to Central Materials on city and county projects. (PCCP Only)

PORTLAND CEMENT & READY MIX
PLANT CALIBRATION CHECKLIST

References: IM 527, 528 and noted Specifications

STORAGE & HANDLING OF MATERIALS

Aggregates: 2301.13

- Certified compliance
- Separation of materials
- Storage area floor shall be a minimum of 18" of similar material
- Fine aggregates shall drain a minimum of 24 hours on new bridge deck floors-2412.02

Cementitious Material: 2301.13

- Approved certified sources
- No intermingling of products or sources
- Stored in suitable weather proof enclosures

WATER

- Sample when required

ADMIXTURES

- Verify acceptance of lot
- Circulate 5 min. per 100 gal. of solution
- Proper storage to prevent freezing

PLANT REQUIREMENTS

Safety:

- Guards, ladders, railings and walkways
- Sampling location
- Proper template if belt sample
- Safety switches and belt lockouts in place
- Bins are structurally safe: 2001.06
- Settlement of footings is uniform
- Suitable wind protection for scale operation
- Automatic interlocks for projects over 6000 sq. yds: 2001.20 & 2301.13
- Weight indicator or digital readouts are in full view of the plant operator.

Scale Calibration: 2001.20

Calibration of batch plant scales as required by the specifications is performed by incrementally loading the scales with standard test weights and partial batches through the operating range of the scales. As each increment of load is applied, the actual observed weight and the required weight are compared. The differences plus or minus, are determined and converted to percentages of the required weight. If the percentage deviations are less than the tolerance allowed by the specifications and the scales are sensitive to the test loads, the scales will be considered in calibration. If the scales do not meet the various requirements, the contractor should be notified immediately and required to make the necessary repairs or adjustments. The engineer may order recalibration if the scale equipment malfunctions, material quantities do not agree with actual material quantities, or any repairs or replacement of equipment occurs.

- Calibrate scales to include the maximum weight for projected batches
- Commercially manufactured weights that have the weight stamped on the exterior and appear to be unaltered and in good condition may be assumed to meet the requirements of ASTM E617.
- Non-commercially manufactured test weights may be used in providing accumulating weight for loading the scales, if validated against commercially manufactured test weights.
- Accumulate calibration error at each increment that material replaces known weight.

NOTE: Example uses 2000 lbs. of known weights applied at 1000 lb. increments. Accumulated error applies only when exchanging known weight with material.

Applied Wt.	Scale Reading	Error	Accum. Error	Wt. Replaced By Material
1000	995	-5		
2000	1995	-5	-5*	yes
3000	2990	-10	-15	<
4000	3995	-5	-10*	yes
5000	5000	0	-10	<
6000	6005	+5	-5*	yes
7000	7010	+10	+5	<

NOTE: *Accumulated error is from last known error prior to material replacement.

< Intermediate errors are measured to determine specification compliance, but are not part of the accumulated result.

As a guide, a working form to help record field calibration measurements is on page 4.

Water Calibration: 2001.20B

- Equipment shall be such that accuracy will not be affected by variations in pressure of the water supply.
- Weighing equipment to verify water calibration shall meet specification
- Repairs or adjustments will require equipment to be recalibrated.

Equipment for Dispensing Liquid Admixtures: 2001.20C

- Calibrate per Specification
- Measuring container of digital readout shall be on view of plant operator.

Truck Mixer & Agitator: 2001.21B

- Meet the requirements of specification
- Truck mixer certification (Form #820907) kept in truck and is up to date.

CONCRETE PLANT CALIBRATION WORKSHEET

DATE ____________________ ____ PAVING PLANT

LOCATION ________________ ____ READY MIX PLANT

CEMENT SCALE – ACCURATE TO 0.5% OF BATCH WEIGHT

SENSITIVITY – EMPTY ________ FULL ________ LBS. @ ________ LBS.
TOLERANCE – 0.1% OF BATCH WEIGHT OR 2 LBS., WHICHEVER IS GREATER

applied weight	scale reading	error	accum. error	applied weight	scale reading	error	accum. error

AGGREGATE SCALE – ACCURATE TO 0.5% OF BATCH WEIGHT

SENSITIVITY – EMPTY ________ FULL ________ LBS. @ ________ LBS.
TOLERANCE – 0.1% OF BATCH WEIGHT OR 2 LBS., WHICHEVER IS GREATER

applied weight	scale reading	error	accum. error	applied weight	scale reading	error	accum. error

WATER-ACCURATE TO +/-1.0% OR 2 LBS., WHICHEVER IS GREATER

ADMIXTURES-ACCURATE TO +/-3.0% OF QUANTITY REQUIRED

metered		scale reading	error	area		water reducer		Retarder	
gal.	lbs.			meter oz.	meas. oz.	meter oz.	meas. oz.	meter oz.	meas. oz.

STRUCTURAL CONCRETE PLANT INSPECTION

GENERAL

Refer to IM 527 (General, Safety).

The following instruction is to be used when inspecting the operation of a ready mix concrete plant typically used for structural concrete, patching, and other concrete items.

EQUIPMENT

1. ELEVATED, LOW PROFILE, AND GROUND-LEVEL BINS

   Refer to IM 527 (Equipment Bins) and the following:

   Permanent structural concrete plants often have facilities for storing sizable quantities of a number of different aggregates. There is a tendency for the stockpiles to become too large for the available area and for the bins to be filled beyond their normal capacity. Aggregates thus tend to become intermingled. Aggregates may also become contaminated with foreign material from a number of sources, including the material, which underlies some stockpiles, if proper care is not taken. Materials, which have been intermingled or otherwise contaminated, must not be incorporated into the work.

2. PROPORTIONING EQUIPMENT

   Requirements for scales or meters for proportioning aggregates, cement, fly ash, water or air entraining agents or other admixtures are found in Article 2001.20 of the Standard Specifications, as modified by Supplemental Specifications. These requirements are in addition to Section 1 above for elevated bins.

   It is the duty of the District Materials Engineer to examine and evaluate all proportioning and plant equipment annually, and maintain a current list of approved structural concrete plants. The Calibration Report, Form #820917, with any appropriate restrictions, conditions, comments, etc., will be posted at the plant site. (See IM 527, Appendix C for a sample copy and Appendix D for calibration checklist.) Before concrete work begins on a project, the Project Engineer must communicate with the District Office and determine that the plant to be used has received annual approval.

   The plant inspector must be familiar with all features of the plant operation before work begins. While the inspector must not personally make any of the manipulations or adjustments, an understanding of the basic machinery operation and the ability to recognize the significance of a malfunction is important.

   The proportioning equipment must be examined at regular intervals during a placement for correctness of the amount being delivered and for possible damage or malfunction. Special attention must be given to the empty balance and the position of the poise weights for beam and dial scales.

The normal plant operation causes vibration, which tends to change these adjustments. Accumulation of material clinging to the inside of the hoppers can also cause these adjustments to drift. Small amounts of material accumulation clinging to the inside of a hopper are not considered objectionable. If the amount exceeds one percent of the material batch, however, it must be removed and readjusted to indicate a zero load within 0.5% (Article 2001.20).

The scale sensitivity shall be checked at least at the beginning of a placement if operations are intermittent, and at the beginning of each day if the operations are continuous in the following manner:

> Place a mass equal to 1/10 percent of the batch on the fully-loaded scales while observing the movement of the indicator.

A properly sensitive scale will exhibit a visible indicator movement when tested in this manner. If no indicator movement is visible and immediate corrective action by the owner does not yield successful results, the District Materials Engineer must be informed.

Periodic observation of the measuring operation must be made to determine that the proper amounts of materials are being delivered to the concrete batch. The plant inspector must be able to recognize when the hopper is overloaded or underloaded by one percent of the batch. For a dial scale, these limits are readily recognizable on the graduated dial chart. For scales with a balance indicator, the location of the indicator hand when a one percent over and underload is applied and removed can be noted before work begins.

If an examination reveals that the scales are not properly sensitized or the proper amounts of material are not being furnished to the concrete batch, refer to IM 527, General, for the necessary action.

Document all routine scale sensitivity, delivery tolerance checks and any necessary corrective action taken, in the plant inspection diary.

The following procedure is required for setting or adjusting the various items of proportioning equipment so that they will deliver the proper amount of material to the batch:

- The plant superintendent or other authorized operator representative must make all necessary scale and equipment setting and/or adjustments. The plant inspector is specifically directed not to participate in this activity.

- Before the plant operation begins or resumes, the plant inspector will independently determine for himself/herself that the settings and/or adjustments are correct and that the amounts of material being delivered to the batch are correct. Errors must be corrected immediately. Strict adherence to the above procedure is necessary to maintain a proper division of authority and responsibility between the contractor and the contracting authority, and to minimize the possibility of operating with erroneous proportions.

Suitable wind protection on all sides of the scales is required by the specification. This protection, if not provided by the plant design, can be fabricated from burlap, masonite, plywood or other suitable material and should provide adequate room for the scale operator to work unobstructed.

An air-entraining admixture is required for all structural concrete, except Class X, and can be proportioned either manually or automatically. Mechanical dispensers must have a transparent measuring chamber so that each batch can be observed as it is measured and dispensed. Mechanical dispensers must be cleaned daily to minimize the possibility of deposits accumulating and causing a malfunction.

The amount of air entraining admixture required is determined by the results of the pressure meter air tests run on the plastic concrete, as described in IM 318. The contractor must decide the quantity to be used and the adjustments necessary, if any, after the pressure meter testing has been completed. Provision shall be made for agitation of the air-entraining agent. (See Article 4103.01A)

An admixture for set retardation may be required. The list of approved retarding admixtures, and recommended dosages, is found in IM 403. An admixture for water reduction may be used at the contractor's option in mixes so designated in IM 529. (See Article 2301.04D.)

See IM 527 (Materials, Admixtures), regarding dosage, handling and storage of admixtures.

Most air entraining and retarding admixtures, when intermingled with each other tend to neutralize each other and negate the effects of each. Care must therefore, be taken to introduce each admixture into the mixer separately and allow the first to become intermingled into the batch before the second is introduced. A procedure, which has been used successfully, is to introduce the air-entraining agent first along with most of the mixing water and other ingredients, and after these have become intermingled then introduce the balance of the mixing water and the retardant admixture.

3. MIXING EQUIPMENT

Mixing equipment for structural projects will be one of the following types:

Truck-mounted transit mixers
Stationary central mixers with in-transit agitation
Stationary mixers located at the project site
Concrete-Mobiles

The truck-mounted transit mixers are the most popular with stationary, central mixers increasing in popularity. Stationary site mixers are seldom used.

Refer to IM 527 (Mixing Equipment) for inspection instructions relating to stationary central mixers and truck-mounted transit mixers, and IM 534 for Concrete-Mobiles.

Transit mixers must carry a current certification signed by a responsible company representative stating that the mixer condition has been examined during the previous 30 days, is free of hardened concrete, and is in proper working condition. Mixers not carrying the required certification must not be used.

MATERIAL

Refer to IM 527 (Material) for the necessary inspection instructions relating to material identification, handling and storage.

SAMPLING & TESTING

1. AGGREGATES

Refer to IM 527 (Sampling & Testing) for related inspection instructions.

The minimum frequencies for testing aggregates for structural concrete vary slightly from those for pavement and are as follows:

Specific Gravity - One sample per week for both coarse and fine aggregate for the first two weeks of concrete placement, and one sample for both coarse and fine every other week thereafter, unless the first two tests indicate variations greater than 0.02 from the tabular value T203, Aggregate Source Information, or from one test to the next. If the above variations are greater than 0.02, inform the Project Engineer and the District Materials Engineer immediately. The District Materials Engineer may adjust the specific gravity used to determine batch weights.

Moisture - One sample for each aggregate per lot. If a system with instantaneous moisture content measurement equipment is used to automatically adjust individual batch weights, see section titled Sampling & Testing/Moisture in IM 527 for instructions on approval, use, and monitoring of the system.

Gradation – One sample for each aggregate per lot.

Lots are based on amount concrete produced from the plant and may include more than one project. For structural concrete operations, a quality control lot shall consist of one day's run or approximately 250 cubic yards (190 m³) whichever is greater. If less than 250 cubic yards (190 m³) are produced in one calendar week that week's work shall be considered as one lot. A bridge deck is considered a lot, unless a bridge deck has over a single day's run, then each day's run shall be considered a lot.

For projects requiring certified plant inspection, the certified inspector will obtain and test one gradation sample per lot, unless operations are prematurely shut down.

Verification sampling and testing will be performed the first day. Thereafter, verification sampling will be performed once per week and testing will be performed on a minimum of 20% of the samples obtained. Also, verification sampling and testing will be performed once per deck pour.

The engineer will perform verification sampling and testing at the frequency described above. IM 205 describes the agency responsibility to randomly select sample location and time, and witness sampling with the contractor providing assistance in obtaining the samples. For small quantities and intermittent production of less than 35 cubic yards (30 cubic meters) per week, verification sampling may be grouped with the previous or subsequent week. A minimum of one sample will be obtained per two week period (grouped as a lot) for each production plant.

Non-Critical Concrete

When non-critical concrete is the only concrete produced for the project(s) from a given plant, quality control testing may be reduced to one gradation per two weeks. Verification sampling and testing for small quantities and intermittent production will apply.

The following Items of work may be designated as non-critical concrete, when placed at less than 35 cubic yards (30 cubic meters) per week:

Concrete Base and Widening
Temporary Pavement
Curb and Gutters
Pavement Patching
Culvert Curtain Wall Concrete
Fence Posts
Sign, Signal and Light Bases
Slope Protection
Building Floors
Catch Basins
Pipe Collars
Intakes
Utility Access
Sidewalks and Driveways
Guard Rail Anchorages
Full PCC Depth Rumble Strip Patch

Non Complying Gradation

When a quality control gradation test does not comply with the gradation requirements of Article 4109, the certified plant inspector shall contact the Engineer. After corrections have been made, the Engineer will obtain and test another verification sample.

When a verification gradation test does not comply with the gradation requirements of Article 4109, the Engineer will contact the contractor and the District Materials Engineer. The District Materials Engineer may investigate sampling and testing procedures, stockpiling, source material, etc. After corrections have been made, the Engineer will obtain and test another verification sample.

Acceptance of lots will be based on complying verification test results. The engineer will retain all samples representing the lots until the lots have been accepted. Since the contracting authority tests are verification, correlation with IM 216 is not required, but may be performed as a check of sampling and testing procedures.

2. WATER/CEMENT RATIO

Whenever the water demand, to achieve the desired workability, exceeds the design water/cement ratio and approaches the maximum water allowed the Project Engineer and the District Materials Engineer Office should be notified. At the same time, aggregate moisture contents, batch amounts, cement scales, water meter, etc., should all be immediately checked. In no circumstance should the maximum water/cement ratio be knowingly exceeded.

If, after the District Materials Engineer investigation and evaluation, additional workability above that which is attainable within the maximum permissible water content is desired, the cement content may be increased in accordance with Article 2403.03A. This should be done only with the approval of the District Materials Engineer or the engineer representative. The District Materials Engineer will provide the revised and adjusted mix proportions for these situations.

Also, in accordance with Article 2403.03C, the engineer may authorize the use of a water-reducing admixture to improve workability. When authorized, only the water-reducing admixtures and dosage rates, as shown in IM 403 should be used.

When calcium chloride solution is added for patching M mix, water included in the calcium chloride solution should not be included in calculation of water-to-cement ratio.

3. STRENGTH TESTS

The test for Modulus of Rupture is the only strength test determined in the field. Test specimens are required for each section placed.

A section is defined as a day's placement of structural concrete. IM 204 lists minimum testing requirements.

Abutment backwalls, pier footings, bridge end posts, and culvert curtain walls are not considered critical structural units and therefore, test specimens are not required from these units, unless directed by the engineer.

Test the flexural specimens as prescribed in IM 316, Flexural Strength of Concrete. Testing shall be done by contract authority personnel.

PROPORTIONS

Refer to IM 527 (Proportions)

REPORTS & REPORTING

1. PCC PLANT PAGE – FORM #240

The same form is to be used for PCC Paving and PCC Structures. Refer to IM 527 for instructions on completing the form and an example form.

Structural Reports are to be recorded in the computer program or on hand-completed forms both provided by the Iowa Department of Transportation. A copy of the completed PCC Plant Page shall be faxed or delivered to the District Materials Engineer within four hours on the next working day after the end of the lot. The Certified Plant Inspector shall keep a copy of the PCC Plant Page and send the original to the Project Engineer. Copies of the files containing the project information will be available to the engineer upon request until the project is final.

A separate report is to be made for each lot of concrete. These reports are to be consecutively numbered for each project.

When computer forms are used, refer to IM 527 for the necessary equipment.

2. READY MIXED CONCRETE, TRUCK TICKET FORM – FORM #830212

Each truckload of concrete must be identified by Form #830212 or an acceptable computer-generated plant ticket. See IM 527.

Iowa Department of Transportation

Office of Materials

October 16, 2007
Supersedes April 17, 2007

Matls. IM 529

PORTLAND CEMENT (PC) CONCRETE PROPORTIONS

GENERAL

Materials for pavement concrete and structural concrete shall be mixed in any one of the following proportions for the class of concrete specified. Each mixture will have specific requirements for the coarse and fine aggregates and the type of cement. Concrete mix proportions include the unit volumes of all materials.

Mix numbers designate numerous aspects of the particular mix. The following is an explanation of the various aspects of the mix number:

- The first letter designates the class of concrete as designated in the contract documents.
- In certain mix designations, the letter V appears after the first hyphen. This indicates either Class V aggregate is to be used. If no letter is shown, aggregate other than Class V shall be used.
- The number indicates the relationship of coarse aggregate to fine aggregate. A mix with a 4 is a 50/50 mix. The following chart shows the number within the mix number and the proportions of the aggregates for each number:

2	is composed of 40% fine and 60% coarse
3	is composed of 45% fine and 55% coarse
4	is composed of 50% fine and 50% coarse
5	is composed of 55% fine and 45% coarse
6	is composed of 60% fine and 40% coarse
7	is composed of 65% fine and 35% coarse
8	is composed of 70% fine and 30% coarse
57	is composed of 50% fine and 50% coarse
57-6	is composed of 60% fine and 40% coarse

- The letters WR indicate water reducer is used in this mixture.
- When a C or an F is shown toward the end of the mix number, fly ash is a part of the mixture and C-fly ash or an F-fly ash, respectively, is used. The percentage of fly ash being used in the mixture shall be designated at the end of the mix number.
- When used as a mineral admixture, Ground Granulated Blast Furnace Slag (GGBFS) shall be designated through the letter "S," followed by the percent substitution, and shown at the end of the mix number. This would be in the same convention used for fly ash substitution. When GGBFS is a portion of a blended cement, the cement type will be designated as IS or IS (M), but special notation will not be made in the mix number.
- The following example illustrates a mix number showing a Class C concrete mixture, 50/50 aggregate proportions, using Class L aggregate, water reducer, and 35% GGBFS substitution.

<u>Example:</u> C - L 4 W R – S35

The following example illustrates a mix number showing a Class C concrete mixture, 50/50 aggregate proportions, using water reducer and a Class C fly ash substitution at a rate of 10%.

Example: C – 4 W R – C10

The following example illustrates a mix number showing a Class C concrete mixture, 50/50 aggregate proportions, using a water reducer, Class C fly ash substitution at 15%, and GGBFS substitution at 35%.

Example: C – 4 W R – C15-S35

The Class D mixtures and the Class V mixtures vary somewhat from the above pattern, but follow the general format.

MIX REQUIREMENTS

General requirements for the mixes are:

1. Fly Ash and GGBFS used in concrete mixtures shall meet the requirements of Section 4108. Fly Ashes for use in concrete mixtures shall be included on the list of approved sources (Materials IM 491.17). GGBFS for use in concrete mixtures shall be included on the list of approved sources (Materials IM 491.14).

2. A water-reducing admixture shall be used in concrete mixtures with the designation as follows: Those mixtures have mixture numbers which have the letters "WR" following a single digit number, all following the first hyphen in the mixture number. These mixtures have reduced cementitious contents to produce concrete of approximately equal strength compared with other mixtures in a particular class of concrete. A water-reducing admixture may be added to other concrete mixtures, without cement reduction, to aid in workability and air entrainment.

   The water-reducing admixture shall meet the requirements of Section 4103 and shall be included on the list of Approved Sources of Water Reducing Admixtures (Materials IM 403, Appendix C). The dosage shall be as described in IM 403.

3. The total quantity of water in the concrete, including water in the aggregate, shall not exceed the maximum water to cement and fly ash ratio.

4. Type I, Type II, Type III, Type I (PM), Type IP, Type I (SM), and Type IS Cement shall be used as provided for in the specifications. All cement shall be from an approved source as per IM 401. The cement type shall be documented on all reports pertaining to a project.

5. The fine aggregates other than Class V (Section 4117) shall meet the requirements of Section 4110 of the current specifications. The coarse aggregates for mixtures using aggregates other than Class V aggregates and excluding Class O concrete (Section 4115.05) mixtures shall meet the requirements of Articles 4115.01 through 4115.04 of the current specifications.

6. When approved by the Engineer, combined fine and coarse aggregate may be used in combination with screened coarse aggregate to produce proportions specified for Class D and Class X concrete mixtures according to the percentage of particles passing the No. 4 sieve in the combined aggregate at the time the material is used.

7. With Engineer approval, proportions designated for mixtures A-V, B-V or C-V with and without fly ash may be substituted for Class X concrete.

8. With Engineer approval, Class M concrete may be substituted for Class A, Class B or Class C concrete.

A-MIX

A-Mixes are specified primarily as paving mixes. They have a lower cement content and lower ultimate strength when compared to a Class C-Mix. A-Mix is commonly used on lower traffic roadways.

B-MIX

B-Mixes are specified primarily as paving mixes. They have the least amount of cement of any paving mix. The strength is also lower than for other paving mixes. B-Mix is commonly used on lower traffic roadways.

C-MIX

C-Mixes are specified for use in both paving and structures. It is the normal paving mix used in primary paving. Typical structural uses would include box culverts, bridge piers, bridge abutments, and most bridge decks.

D-MIX

D-Mixes are specified for use primarily in structures. A typical use includes drilled shafts.

M-MIX

M-Mixes are designed for high early strength, suitable for many applications for which they are allowed. Calcium chloride should only be used when needed, for patching and other placements without steel reinforcement.

O-MIX

O-Mixes are specified for low slump concrete, primarily for use in bridge deck overlays. The water-cement ratio is intended to be controlled by the slump specified elsewhere for concrete where these mixtures are used. A water-reducing agent, which meets the necessary requirements of IM 403, is required for this mix. The dosage shall be as described in IM 403. O-Mixes require coarse aggregate specifically intended for repair and overlay. See Specification 4115.06.

X-MIX

X-Mixes are specified to be used as seal course concrete, primarily in cofferdams. No air entraining is required. No maximum water-cementitious ratio is specified. See Specification 2405.05 for limits on water usage.

QMC

Contractor-designed aggregate proportioning mixes. Minimum absolute volume of cement is 0.106. Maximum water-cement ratio is 0.45.

BR

BR mixes are used in slip form barrier rail in accordance with Section 2513. Required designed aggregate proportioning. The minimum absolute volume of cement is 0.114. Maximum water-cement ratio is 0.45.

CLASS V

Class V is an aggregate classification, specified in Section 4117. The fine limestone aggregates in concrete mixes using Class V aggregate with/without fly ash shall meet the requirements of Article 4117.03 of the current specifications. This material may be used in various concrete mixes, so designated. The mixes utilizing this material will be designated with a Roman numeral V, in the Mix Number.

FLY ASH & GGBFS SUBSTITUTION

At Contractor option, fly ash or GGBFS may be substituted for a portion of the cement in concrete mixes, within the limitations set forth in the appropriate Article for each type of placement. IM 527 gives instructions on how to determine the proper batch proportions in a mix.

When fly ash or GGBFS is substituted for the cement, the replacement shall be on a pound-for-pound (kilogram-for-kilogram) basis. Tables 1 and 2 define concrete mixes with no substitution. These mixes shall be used as the basis for determining the final batch proportions and shall be adjusted accordingly. The change in volume resulting from the substitution shall be determined and an adjustment in both coarse and fine aggregate proportions shall be determined in order to ensure a unit volume. The change in aggregate proportions shall be in the same ratio as that of the specific mix. In those cases where the cement content is increased, relative to the standard design mix, the mix proportions shall be adjusted and a change in the aggregate content shall be determined, as described above.

When both fly ash and GGBFS are substituted for the cement in ready-mixed concrete, the replacement shall be on a pound-for-pound (kilogram-for-kilogram) basis and shall be substituted in the following order. First, fly ash shall be substituted for the cement. Next, GGBFS shall be substituted for the weight (mass) cement minus the pound (kg) of fly ash replacement.

Type IP and Type IS cements shall be considered cement with regard to substitution of fly ash. Refer to appropriate Article for limitations. For pavements, a 20% fly ash replacement of a blended cement with 25% replacement, such as IS(25), is equivalent to a 40% weight replacement of Portland cement. For structures, a 35% replacement with ggbfs and a 20% replacement with fly ash is equivalent to 48% weight replacement of Portland cement.

Proportion Table 1
Concrete Mixes
Using Article 4110 and 4115 Aggregates
Basic Absolute Volumes of Materials Per Unit Volume of Concrete

A MIXES Basic w/c = 0.474 Max w/c = 0.532

Mix No.	Cement	Water	Air	Fine	Coarse
A-2	0.101	0.150	0.060	0.276	0.413
A-3	0.104	0.155	0.060	0.306	0.375
A-4	0.108	0.161	0.060	0.335	0.336
A-5	0.111	0.165	0.060	0.365	0.299
A-6	0.115	0.171	0.060	0.392	0.262

B MIXES Basic w/c = 0.536 Max w/c = 0.600

Mix No.	Cement	Water	Air	Fine	Coarse
B-2	0.088	0.148	0.060	0.282	0.422
B-3	0.091	0.153	0.060	0.313	0.383
B-4	0.093	0.157	0.060	0.345	0.345
B-5	0.096	0.162	0.060	0.375	0.307
B-6	0.099	0.167	0.060	0.404	0.270
B-7	0.102	0.172	0.060	0.433	0.233
B-8	0.105	0.177	0.060	0.461	0.197

C MIXES Basic w/c = 0.430 Max w/c = 0.488

Mix No.	Cement	Water	Air	Fine	Coarse
C-2	0.110	0.149	0.060	0.272	0.409
C-3	0.114	0.154	0.060	0.302	0.370
C-4	0.118	0.159	0.060	0.331	0.332
C-5	0.123	0.166	0.060	0.358	0.293
C-6	0.128	0.173	0.060	0.383	0.256

C-WR MIXES Basic w/c = 0.430 Max w/c = 0.489

Mix No.	Cement	Water	Air	Fine	Coarse
C-3WR	0.108	0.146	0.060	0.309	0.377
C-4WR	0.112	0.151	0.060	0.338	0.339
C-5WR	0.117	0.158	0.060	0.366	0.299
C-6WR	0.121	0.163	0.060	0.394	0.262

D MIXES Basic w/c = 0.423 Max w/c = 0.450

Mix No.	Cement	Water	Air	Fine	Coarse
D-57	0.134	0.178	0.060	0.314	0.314
D-57-6	0.134	0.178	0.060	0.377	0.251

M MIXES Basic w/c = 0.328 Max w/c = 0.400

Mix No.	Cement	Water	Air	Fine	Coarse
M-3	0.149	0.153	0.060	0.287	0.351
M-4	0.156	0.161	0.060	0.311	0.312
M-5	0.160	0.165	0.060	0.307	0.308

O MIXES Basic w/c = 0.327 Max w/c = ------

Mix No.	Cement	Water	Air	Fine	Coarse
O-4WR	0.156	0.160	0.060	0.312	0.312

Basic w/c = 0.400 Max w/c =0.420-

HPC-O	0.134	0.168	0.060	0.316	0.317

X MIXES Basic w/c = 0.423 Max w/c = ------

Mix No.	Cement	Water	Air	Fine	Coarse
X-2	0.124	0.165	0.000	0.284	0.427
X-3	0.129	0.171	0.000	0.315	0.385
X-4	0.134	0.178	0.000	0.344	0.344

Above mixtures are based on Type I or Type II cements (Sp. G. = 3.14). Mixes using blended cements (Type IP or IS) must be adjusted for cement gravities listed in IM 401.

Proportion Table 2
Concrete Mixes
Using Class V Aggregates Combined with Limestone
Basic Absolute Volumes of Materials Per Unit Volume of Concrete

V47B MIXES

Mix No.	**Cement**	**Water**	**Air**	**Class V.**	**Coarse Limestone**	**Basic w/c**	**Max. w/c**
A-V47B	0.107	0.148	0.060	0.479	0.206	0.440	0.560
B-V47B	0.098	0.160	0.060	0.477	0.205	0.520	0.597
C-V47B[1]	0.107	0.148	0.060	0.479	0.206	0.440	0.560*
C-V47BF[2]	0.114	0.141	0.060	0.479	0.206	0.420	0.488*

V MIXES

Mix No.	**Cement**	**Water**	**Air**	**Class V.**	**Fine Limestone**	**Basic w/c**	**Max. w/c**
A-V	0.135	0.188	0.060	0.586	0.031	0.444	0.467
B-V	0.135	0.188	0.060	0.586	0.031	0.444	0.467
C-V	0.135	0.188	0.060	0.586	0.031	0.444	0.467
M-V	0.160	0.196	0.060	0.555	0.029	0.390	0.420

Above mixtures are based on Type I or Type II cements (Sp. G. = 3.14). Mixes using blended cements (Type IP or IS) must be adjusted for cement gravities listed in IM 401.

*The maximum w/c shall be 0.450 when used in concrete pavement.

[1] C-V47B mix shall be used when Type I/II cements are used with Class F fly ash or ggbfs.

[2] C-V47BF mix shall be used when Type IP or Type IS cements are used.

QUALITY MANAGEMENT & ACCEPTANCE
PC CONCRETE PAVEMENT

GENERAL

This Instructional Memorandum is based on the concept of mutual benefit partnership between the Contracting Agency and the Contractor during progress of the work. Technical partnering shall be a part of this work and a formal partnership agreement may or may not be in effect.

The Contractor shall submit and comply with a Quality Control Program. The Contractor shall be responsible for the design of a Portland Cement Concrete Design Mixture (CDM) for use in pavement and shall be approved by the District Materials Engineer. The Contractor shall perform process control sampling, testing, and inspection during all phases of the concrete work at the rate specified in the contract documents, with monitor inspection by the agency personnel. Inspection of all other aspects of the concrete paving operation remains the responsibility of the Engineer.

The Contractor shall have an Iowa DOT PCC Level II Certified Technician responsible for all process control sampling and testing and execution of the Quality Control Plan as specified in the specification and this Instructional Memorandum. An Iowa DOT PCC Level I Concrete Field Testing Technician or Technician Grade I (in accordance with ACI CP-2) may perform the sampling and testing duties for which he or she is certified.

MIX DESIGN PROCEDURE

An Iowa DOT PCC Level III Certified Technician shall perform the mix design. The Engineer shall concur with the Contractor designee.

The CDM shall be developed using the Excel spreadsheet developed by the Office of Materials. ACI 211 procedure, PCA procedure, or alternative methods may also be used. Aggregate proportions are contained on Form #955QMC (IM 532, Appendix A). When a CDM is developed, the absolute volume method shall be used.

The Contractor shall submit the CDM with test data, including a list of all ingredients, the source of all materials, target gradation, and the proportions, including absolute volumes.

A CDM with a satisfactory record of performance strength may be submitted in lieu of a new CDM. The concrete used for paving per this IM shall be produced with the same material sources and batched and mixed with the same equipment used to produce the concrete represented by the performance strength documentation.

For each proposed aggregate proportion, the 28-day flexural strength shall be determined at the proposed cementitious content. The CDM shall be based on the 28-day strength and the average of a minimum of three tests per mixture.

QUALITY CONTROL PLAN

The Contractor shall submit a Quality Control Plan listing the type and frequency of inspection, sampling, and testing deemed necessary to measure and control the various properties of materials and construction governed by the specifications. As a minimum, the sampling and testing plan shall detail sampling location, sampling procedures, and the test frequency to be utilized. This Contractor Quality Control Plan shall be submitted to the PCC Engineer and will be retained for use on all QMC projects. A copy of the Quality Control Plan shall be available on the project at all times. Periodic updates may be required as necessary.

A Project Information Quality Control Plan shall be submitted for each project. The plan shall identify the personnel responsible for the contractor quality control. This should include the company official who will act as liaison with Iowa DOT personnel, as well as the certified technician who will direct the inspection program. The certified technician shall be responsible to an upper level company manager and not to those responsible for daily production. The project information plan shall also include the mix design and mix design properties.

A. Elements of the Quality Control Plan

The plan shall address all elements that affect the quality of the concrete, including but not limited to, the following:

1. Stockpile management
2. Mixing time and transportation, including time from batching to completion of delivery and batch placement rate (batches per hour)
3. Placement and consolidation
4. The frequency of sampling and testing, coordination of activities, corrective actions to be taken, and documentation
5. How the duties and responsibilities are to be accomplished and documented, and whether more than one certified technician would be provided
6. The criteria used by the technician to correct or reject noncompliant materials, including notification procedures

B. Personnel Requirements

1. Perform and utilize process control tests and other quality control practices to ensure that delivered materials and proportioning meets the requirements of the mix design(s).
2. Periodically inspect all equipment utilized in transporting, proportioning, mixing, placing, consolidating, finishing, and curing to ensure proper operation. Monitor placement, consolidation, finishing, and curing to ensure conformance with the mix design and other contract requirements.

The Project Information Quality Control Plan shall be submitted in writing to the Engineer for the project. The Contractor shall not start paving until receipt of the approval of the Project Information Quality Control Plan.

C. Elements of Project Information Quality Control Plan

1. Mix design(s)
2. Mix design properties, as specified in the Specifications
3. The Contractor shall furnish name(s) and credentials of the quality control staff to the Engineer prior to the beginning of construction.
4. Project-related information

DOCUMENTATION

The Contractor shall maintain records of all inspections and tests. The records shall indicate the nature and number of observations made, the number and type of deficiencies found, the quantities represented by the test, and any corrective action taken. The contractor documentation procedures will be subject to the approval of the Iowa DOT prior to the start of the work and prior to regular monitoring during the progress of the work. Use standard Iowa DOT forms. Batch tickets and gradation data shall be documented in accordance with Iowa DOT requirements. Copies shall be submitted to the engineer as work progresses.

A control chart and running tabulation of individual test results shall be prepared for the following tests. An Excel spreadsheet is available from the Office of Materials to plot the test results. These shall be available to the Engineer at any time and submitted to the Engineer weekly:

1. Gradation (% passing) for each of the following sieves: 1 1/2 in. (37.5 mm), 1 in. (25 mm), 3/4 in. (19 mm), 1/2 in. (12.5 mm), 3/8 in. (9.5 mm), #4 (4.75 mm), #8 (2.36 mm), #16 (1.18 mm), #30 (600 μm), #50 (300 μm), #100 (150 μm), #200 (75 μm), and pan.
2. Moisture: Coarse Aggregate(s) & Sand
3. Unit Weight
4. Plastic Air Content
5. Coarseness & Workability Factors
6. Water/cementitious Ratio

Charting will be completed within 24 hours after testing. Working range limits shall be indicated on the control charts.

The Contractor shall notify the Engineer whenever the process approaches a specification limit and shall take action, which results in the test results moving toward the specification target, away from the limit.

All charts and records documenting the contractor quality control inspections and tests shall become property of the Iowa DOT upon completion of the work.

The PCC Level II Technician shall document the changes to the mix design, allowed by the specification, on the Iowa DOT QM-C Mix Adjustment form (IM 530, Appendix A). The PCC Level III Technician shall concur with the changes and shall periodically review mix changes affect on workability and placement in the field.

FIELD VERIFICATION TESTING

For continuous construction operation, a lot will be defined as a week of paving. Lots less than three days of paving will be grouped with the previous week lot. Intermittent construction operation involving quantities less than 250 cubic yards per day, shall be grouped to establish a lot, not to exceed one week. The Engineer will perform verification testing at the following minimum test frequencies:

MINIMUM TEST FREQUENCIES

	Verification	
Unit Weight Plastic Concrete	None	IM 340
Gradation (Individual aggr., % passing)	1st/day, then twice per lot	IM 302
Flexural Strength, Third Point Loading - 28 days *	1/10,000 cu. yd. (1/10,000 m^3)	IM 328
Air Content Unconsolidated Concrete	1/700 cu. yd. (1/550m^3)	IM 318
Water/Cement Ratio	None	IM 527
Vibration Frequency	1/week	IM 384

*One set of two beams at the above rate, with a maximum of five sets per project, shall be cast for pavement design purposes. The beams shall be delivered to the Central Laboratory in Ames for testing. Transported beams shall be stripped and wrapped in wet burlap and plastic to ensure adequate curing during delivery. Include information on project number, contractor, date cast and air content with delivery. Date of testing will be increased to 90 days when quartzite coarse aggregate is used.

CONTROL & ACCEPTANCE PROCESS OF PLASTIC AIR TESTING

On the first air test of each day, the Contractor and Agency shall run side by side tests to ensure both air meters are within the tolerance in IM 216. If the air tests are outside the tolerance, both air meters should be calibrated in accordance with IM 318 to resolve the difference.

Thereafter, the Engineer will randomly test the plastic air content at the minimum frequency in the table above. The Contractor may elect to run side by side comparison at the same time as the Engineer to ensure both meters are operating properly. When a verification test result is outside the tolerance for the target air content, the Contractor will be immediately notified.

The unconsolidated air content limits will be established according to Article 2301.04C using Contractor test results. The Contractor shall notify the Engineer whenever an individual quality control test result is outside the tolerance for the target air content. Lot acceptance shall be based on the agency verification test results on the unconsolidated mix on the grade.

DETERMINING COARSENESS & WORKABILITY INCENTIVE

On the first day of paving, the Engineer will direct and witness sampling and splitting of one sample of each aggregate. The split sample shall meet the requirements of IM 216. If correlation is not established, the District Materials Engineer will resolve the differences.

Thereafter, The Engineer will direct and witness sampling of one random independent sample per day. The agency will take immediate possession of the samples. The Engineer will randomly test a minimum of two samples per lot. The Engineer will determine aggregate percentages based on the batch weights at the time the sample was obtained, compute the average coarseness and workability factors in accordance with IM 532 for the combined samples tested, and average the results. If the average results obtained by the Engineer fall within the same pay zone as the Contractor, appropriate incentive will be paid for the lot.

If the average results obtained by the agency are not in the same pay zone as the Contractor, the Engineer will test the remaining samples representing the lot and average all results for the lot. If the average results of all verification samples for the lot fall within the same pay zone as Contractor results for the lot, incentive will be paid for the lot. If the average results of all verification samples for the lot are in a different pay zone than Contractor, the agency results will govern for the basis of incentive for the lot.

CORRECTIVE ACTION

The Contractor shall take prompt action to correct conditions that have resulted, or could result, in the incorporation of noncompliant materials.

NONCOMPLIANT MATERIALS

The Contractor shall establish and maintain an effective and positive system for controlling noncompliant material, including procedures for its identification, isolation and disposition. Reclaiming or reworking of noncompliant materials shall be in accordance with procedures acceptable to the Iowa DOT.

All noncompliant materials and products shall be positively identified to prevent use, shipment, and intermingling with conforming materials and products.

AVOIDANCE OF DISPUTES

Every effort should be made by Contractor and Engineer personnel to avoid any potential conflicts in the Quality Assurance Program prior to and during the project by using partnering concepts. Potential conflicts should be resolved at the lowest possible levels between the Contractor and Engineer personnel. Correction of problems and performance of the final product should be the primary objective of this resolution process.

TESTING

If less than 500 cu. yd. (500 m^3) are produced in one day that day's production may be grouped with the following day's production.

******THIS IS A NEW APPENDIX. – PLEASE READ CAREFULLY.******

IOWA DOT QM-C MIX ADJUSTMENT FORM

Project Number:

Contractor:

Date of Mix Adjustment (m/d/yy):

Station of Mix Adjustment:

Number of Mix Changes to Date:

Old Mix ID:

New Mix ID:

Mix Adjustment 1:
Reason:

Mix Adjustment 2:
Reason:

Mix Adjustment 3:
Reason:

	Old Mix Proportions		New Mix Proportions	
	Source	SSD Weight or Dosage	Source	SSD Weight or Dosage
Cement				
Fly Ash				
Water				
Coarse Aggregate				
Intermediate Aggregate				
Fine Aggregate				
Air Entraining Agent				
Water Reducer				
Retarder				

*PCC II Technician*____________________________ *Cert No.* _______________

Copies To: District Materials Engineer
Resident Construction Engineer

Iowa Department of Transportation
Office of Materials

October 19, 2004
Supersedes October 26, 1999

Matls. IM 531

TEST METHOD FOR COMBINING AGGREGATE GRADATIONS

When the aggregate gradations for a PCC mixture are sampled and tested individually, the results must be mathematically combined to create a theoretical combined gradation. This combined gradation is based on their relative percent volume in the mixture.

Each individual aggregate gradation shall start with the largest appropriate sieve for that material and shall include all the consecutive smaller sieve sizes through the #200 (75-µm) sieve. They shall include: 1/2-in. (37.5-mm), 1-in. (25-mm.), 3/4-in. (19-mm), 1/2-in. (12.5-mm), 3/8-in. (9.5-mm), #4 (4.75-mm), #8 (2.3-mm), #16 (1.18-mm), #30 (600-µm), #50 (300-µm), #100 (150-µm), and #200 (75-µm) sieves. For coarse and intermediate aggregates, the #16 (1.18-mm) through #100 (150-µm) sieves may be determined mathematically.

The following methods outline the procedures to be used to determine the combined gradation. Method A is generally used for most aggregate combinations. Method B should be used when the specific gravity of the individual aggregates differ by more than 0.25.

METHOD A

Multiply relative percentage by the percent passing and sum all aggregates for each sieve size.

P = Aa + Bb + Cc
P = Combined percent passing of a given sieve
A,B,C = Percent passing given sieve for aggregate A, B, and C
a,b,c = Relative percent of total aggregates A, B, and C

Convert combined percent passing to combined percent retained by subtracting the combined percent passing on the top sieve from 100 and the combined percent passing from each subsequent sieve, thereafter.

Sieve	**Coarse Aggregate**	**Intermediate Aggregate**	**Fine Aggregate**	**Theoretical Combined Gradation % Passing**	**Theoretical Combined Gradation % Retained**
Relative Percent→	0.472	0.118	0.410		
1 1/2 inch	100	100	100	100	0.0
1 inch	83	100	100	92	8.0
3/4 inch	65	100	100	83.4	8.5
1/2 inch	35	100	100	69.3	14.2
3/8 inch	14	100	100	59.4	9.9
No. 4	2.1	33	96	44.2	15.2
No. 8	0.9	2.8	82	34.4	9.8
No. 16	0.8	2.3	63	26.5	7.9
No. 30	0.7	1.8	37	15.7	10.8
No. 50	0.5	1.2	9.4	4.3	11.4
No. 100	0.4	0.7	1	0.7	3.6
No. 200	0.3	0.1	0.4	0.3	0.4

METHOD B

STEP 1:

The percent volume of each of the aggregates is determined from the volume proportions of the mixture design. The relative proportion of each aggregate of the total aggregate is determined by dividing the individual aggregate portion in the mix by the total aggregate portion in the mix.

Example:

A mixture design has the following mix proportions by volume:

Cement	0.110
Water	0.150
Air Entraining	0.070
Fine Aggregate (PCC Sand)	0.270
½ inch Intermediate Aggregate (Limestone Chip)	0.100
1½ inch Coarse Aggregate (Limestone PCC Stone)	0.300
Total	1.000

The total aggregate portion is: 0.270 + 0.100 + 0.300 = 0.670

The relative percent retained portion for each aggregate by volume is determined as follows:

Fine Aggregate (0.270/0.670) = 0.403
Intermediate Aggregate (0.100/0.670) = 0.149
Coarse Aggregate (0.300/0.670) = 0.448

Check the total aggregate relative portions. They should equal 1.000.

0.403 + 0.149 + 0.448 = 1.000 (OK)

STEP 2:

These volume proportions are then adjusted by the specific gravity of the aggregates, since gradations are based on percent weight retained on each sieve. The proportion retained by weight is determined by multiplying each aggregate's volume proportion by its specific gravity. These weights are then summed to obtain a total weight. The proportion by weight is then determined by dividing each aggregate's weight by the total weight.

Example:

Aggregate	Proportion Volume	Specific Gravity	Weight	Proportion By Weight
Fine	0.403	2.67	1.07601	(1.07601/2.64912) = 0.406
Intermediate	0.149	2.59	0.38591	(0.38591/2.64912 = 0.146
Coarse	0.448	2.65	1.18720	(1.18720/2.64912) = 0.448
Total	1.000		2.64912	1.000

STEP 3:

Determine the theoretical combined gradation from the individual gradations. This is done by multiplying the percent retained on each sieve for the individual gradations by the relative portion of the aggregate volumes. Then total the percent retained of each product for each sieve size. This is the theoretical combined percent retained for each sieve. The total of these percents retained should equal 100.0. If the total is off due to rounding, prorate the rounding error.

Example: **Coarse Aggregate**

Sieve	% Retained	Relative Volume	Adjusted % Retained
1 1/2 inch	0.0	0.448	0.0
1 inch	1.4	0.448	0.6
3/4 inch	23.7	0.448	10.6
1/2 inch	31.0	0.448	13.9
3/8 inch	24.5	0.448	11.0
No. 4	14.1	0.448	6.3
No. 16	0.7	0.448	0.3
No. 30	0.8	0.448	0.4
No. 100	0.4	0.448	0.2
No. 200	0.2	0.448	0.1
Minus 200	0.8	0.448	0.4

Similar calculations are done for the intermediate and fine aggregates.

STEP 4:

The individual adjusted gradations are summed to get the theoretical combined gradation, percent retained. The theoretical combined gradation, percent passing, may be calculated by subtracting subsequent sieves beginning with 100, as per IM 302. The following table shows the calculations:

Sieve	Coarse Aggregate	Intermediate Aggregate	Fine Aggregate	Theoretical Combined Gradation % Retained	Theoretical Combined Gradation % Passing
1 1/2 inch	0.0			0.0	100
1 inch	0.6			0.6	99.4
3/4 inch	10.6	0.0		10.6	88.8
1/2 inch	13.9	3.2		17.1	71.7
3/8 inch	11.0	5.4	0.0	16.4	55.3
No. 4	6.3	4.9	2.0	13.2	42.1
No. 8	0.9	0.4	4.1	5.4	36.7
No. 16	0.3	0.3	5.6	6.2	30.5
No. 30	0.4	0.1	12.9	13.4	17.1
No. 50	0.1	0.2	12.0	12.3	4.8
No. 100	0.2	0.1	3.1	3.4	1.4
No. 200	0.1	0.1	0.2	0.4	1.0
Minus 200	0.4	0.2	0.4	1.0	0.0

The theoretical combined gradations are used in graphically displaying aggregate blends of PCC mixture designs and for plotting control charts to compare target gradation with working ranges of the mixture design.

AGGREGATE PROPORTIONING GUIDE FOR PC CONCRETE PAVEMENT

GENERAL

This Instructional Memorandum covers procedures for developing a well-graded aggregate combination for use in Portland Cement Concrete paving. It is the responsibility of the mix designer to design a mix with appropriate properties for the intended application and placement method. The mixture should be economical, meet workability and finishing requirements, and allow for a proper air void system at a minimum water/cementitious ratio. Regardless of how the mix performs in controlled conditions, ultimately it must be evaluated on how well it performs during production and placement in the field.

Concrete mixtures produced with a well-graded aggregate combination tend to reduce the need for water, provide and maintain adequate workability, require minimal finishing, and consolidate without segregation. These characteristics tend to enhance placement properties as well as strength and long-term performance. Concrete mixtures produced with a gap graded aggregate combination tend to segregate easily, contain higher amounts of fines, require more water, and increase susceptibility to shrinkage. These characteristics tend to limit placement properties as well as strength and long term performance.

Achieving a uniform gradation may require the use of three or more different aggregate sizes. It is the responsibility of the mix designer to consider particle shape when designing a mix. When using the coarseness/workability chart it is assumed that particles are rounded or cubical shaped. Rounded or cubical shaped aggregates typically enhance workability and finishing characteristics. Flat and elongated aggregates typically limit workability and finishing characteristics.

COARSENESS/WORKABILITY CHART[1]

The mathematically combined gradation, expressed as percent retained, shall be calculated in accordance with IM 531. The coarseness and workability factors shall be calculated and then plotted in a coarseness/workability chart as shown in Figure 1.

$$\text{Coarseness Factor} = \frac{[\text{combined \% retained above 9.5 mm (3/8 in.) sieve}]}{[\text{combined \% retained above 2.36 mm (No. 8) seive}]} \times 100$$

Workability Factor = Combined % Passing No. 8 (2.36 mm) Sieve*
*The workability factor shall be increased by 2.5% for each increase of 94 pounds of cement over 564 pounds per cubic yard.

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[1] ¹Shilstone, J. Sr., "Concrete Mixture Optimization", Concrete International, June 1990

Shilstone recommends a target of 60 Coarseness Factor and 35 Workability Factor. For a nominal maximum aggregate size of 1 in. to 1 1/2 in. (25 mm to 37.5 mm), Shilstone recommends a Workability Factor of 34 to 38 when the Coarseness Factor is 52 and a Workability Factor of 32 to 36 when the Coarseness Factor is 68.

Aggregate blends that plot close to the bottom boundary line may tend to have too much coarse aggregate. Aggregate blends with a point below the bottom boundary line (Zone V) will produce rocky mixtures with inadequate mortar and shall not be allowed.

Aggregate blends above the top boundary line (Zone IV) will produce sandy mixtures with high amounts of fines requiring higher water contents and potential for segregation.

Aggregate blends with coarseness factors higher than 75 (Zone I) will produce gap graded mixtures with inadequate workability and high potential for segregation.

Aggregate blends with a point in Zone III, respectively, corresponds with Zone II for aggregate sizes less than 1/2 in. (12.5 mm).

0.45 POWER CURVE

The 0.45 power curve is based on the mathematically combined percent passing gradation determined in accordance with IM 531. Historically, the 0.45 power curve has been used to develop uniform gradations for asphalt mix designs; however, it is increasingly being used to develop uniform gradations for Portland Cement Concrete mix designs.

To create a 0.45 power curve plot the mathematically combined percent passing for each sieve on a chart having percent passing on the y-axis and sieve sizes raised to the 0.45 power on the x-axis. Sieve sizes shall include the 1 1/2 in. (37.5 mm), 1 in. (25.0 mm), 3/4 in. (19.0 mm), 1/2 in. (12.5 mm), 3/8 in. (9.5 mm), No. 4 (4.75 mm), No. 8 (2.36 mm), No 16 (1.18 mm), No. 30 (600 µm), No 50 (300 µm), No. 100 (150 µm), and the No. 200 (75 µm). Connect the plotted points as shown in Figure 2. Plot the maximum density line from the origin of the chart to the sieve one size larger than the first sieve to have 90 percent or less passing.

A well-graded aggregate combination will follow the maximum density line to the No. 16 (1.18 mm) sieve. A slight deviation below the maximum density line at the No. 16 (1.18 mm) sieve will occur to account for the effect of the fines provided by the cementitious materials (Figure 2). A gap graded aggregate combination will produce an "S- shaped" curve deviating above and below the maximum density line (Figure 3).

PERCENT-RETAINED CHART

The percent-retained chart is based on the mathematically combined percent-retained gradation for each sieve in accordance with IM 531. The percent-retained chart has evolved from efforts to limit disproportionate amounts of material retained on any one sieve.

To create a percent-retained chart plot the mathematically combined percent retained for each sieve on a chart having percent retained on the y-axis and sieve sizes on the x-axis. Sieve sizes shall include the 1 1/2 in. (37.5 mm), 1 in. (25.0 mm), 3/4 in. (19.0 mm), 1/2 in. (12.5 mm), 3/8 in. (9.5 mm), No. 4 (4.75 mm), No. 8 (2.36 mm), No. 16 (1.18 mm), No. 30 (600 µm), No. 50 (300 µm), No. 100 (150 µm), and No. 200 (75 µm). Connect the plotted points and plot the boundary lines as shown in Figure 4.

A well-graded aggregate combination will have no significant peaks and/or dips (Figure 4). A gap graded aggregate combination will have significant peaks and dips (Figure 5). Shilstone recommends that the sum of percent retained on two consecutive sieves should be at least 13% to be an optimum gradation.

OPTIMUM AGGREGATE BLEND

Determining an optimum combined aggregate blend will require the use of all 3 graphical representations as well as sound practical experience. The coarseness/workability chart should be the primary method used to develop an aggregate combination that will produce a mixture with appropriate properties for the intended application and placement method. The 0.45 power curve and the percent-retained chart should be used as secondary means to verify the coarseness/workability chart results and to identify areas deviating from a well-graded aggregate combination. Aggregate blend for QMC mixes may be found on Form #955QMC (Appendix A).

For BR mixes, a well-graded aggregate mix design on the coarseness/workability chart will typically fall in a parallelogram approximated by a workability factor between 35 and 42.5 at a coarseness factor of 45 and a workability factor between 32 and 38 at a coarseness factor of 70 in (Zones II-A, II-B, and II-C).

AGGREGATE SHAPE EFFECT ON OPTIMUM GRADATION

The shape and texture of aggregate particles affect the volume of paste needed to coat particles and decrease interactions during placement. The ideal aggregate shape for workability is smooth and round. Smooth and round particles, such as gravels, have a low surface to volume ratio and require less paste to coat the surfaces of each particle. Crushed limestone aggregates, which usually tend to be more angular and rough than gravel aggregates, have a higher surface to volume ratio, and may require more paste to reduce particle interactions.

These rules are generalized and the mix designer must determine the actual optimum gradation, considering particle shape, with placing and finishing characteristics as the ultimate assessment of workability. Although other combinations can be used depending on aggregate top size, shape, and texture, typical optimum aggregate combinations tend to fall within the range of 58-62% coarse to 42-38% fine aggregate ratio, with 15-25% intermediate aggregate in the coarse fraction.

FIGURE 1

[1] Workability Factor VS Coarseness Factor for Combined Aggregate

Assumptions: 564 lbs cement per cubic yard, 1 inch Aggregate, and Slipformed

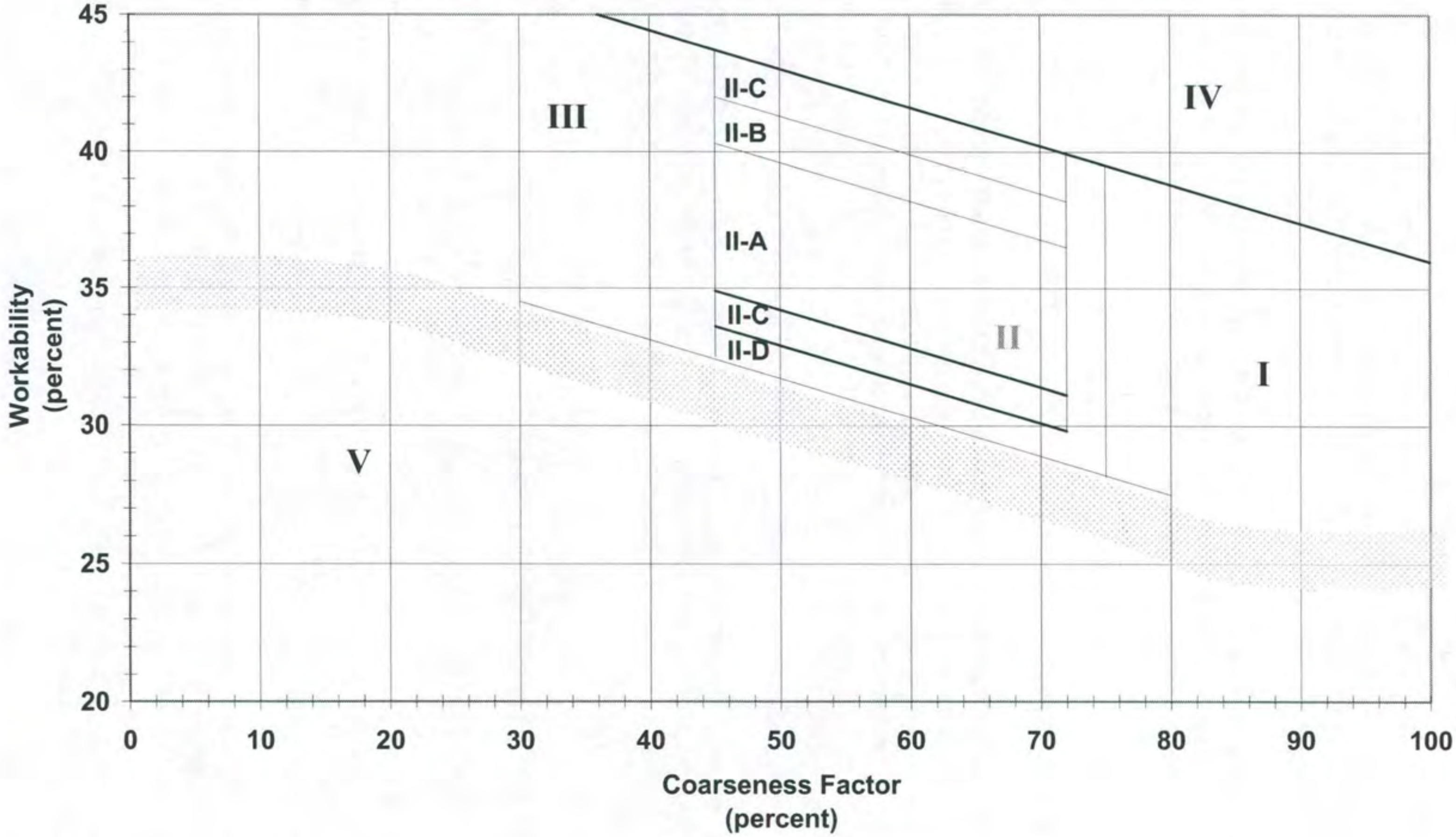


FIGURE #2

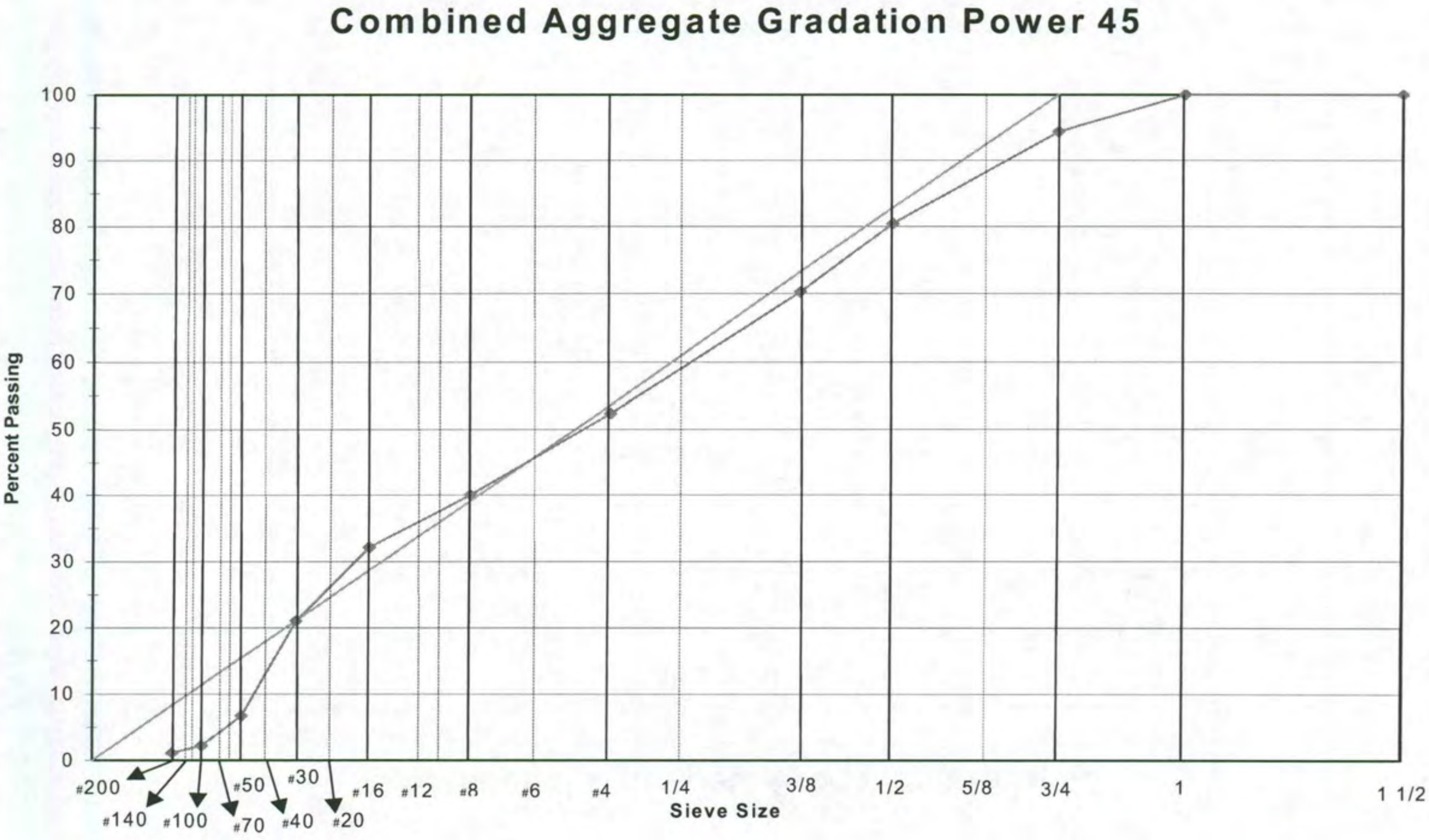

Combined Aggregate Gradation Power 45
Percent Passing
100
90
80
70
60
50
40
30
20
10
0
#200
#140
#100
#70
#50
#40
#30
#20
#16
#12
#8
#6
#4
1/4
3/8
1/2
5/8
3/4
1
1 1/2
Sieve Size

FIGURE 3


Combined Aggregate Gradation Power 45
Percent Passing
100
90
80
70
60
50
40
30
20
10
0
Sieve Size
#200
#140
#100
#70
#50
#40
#30
#20
#16
#12
#8
#6
#4
1/4
3/8
1/2
5/8
3/4
1
1 1/2

FIGURE 4

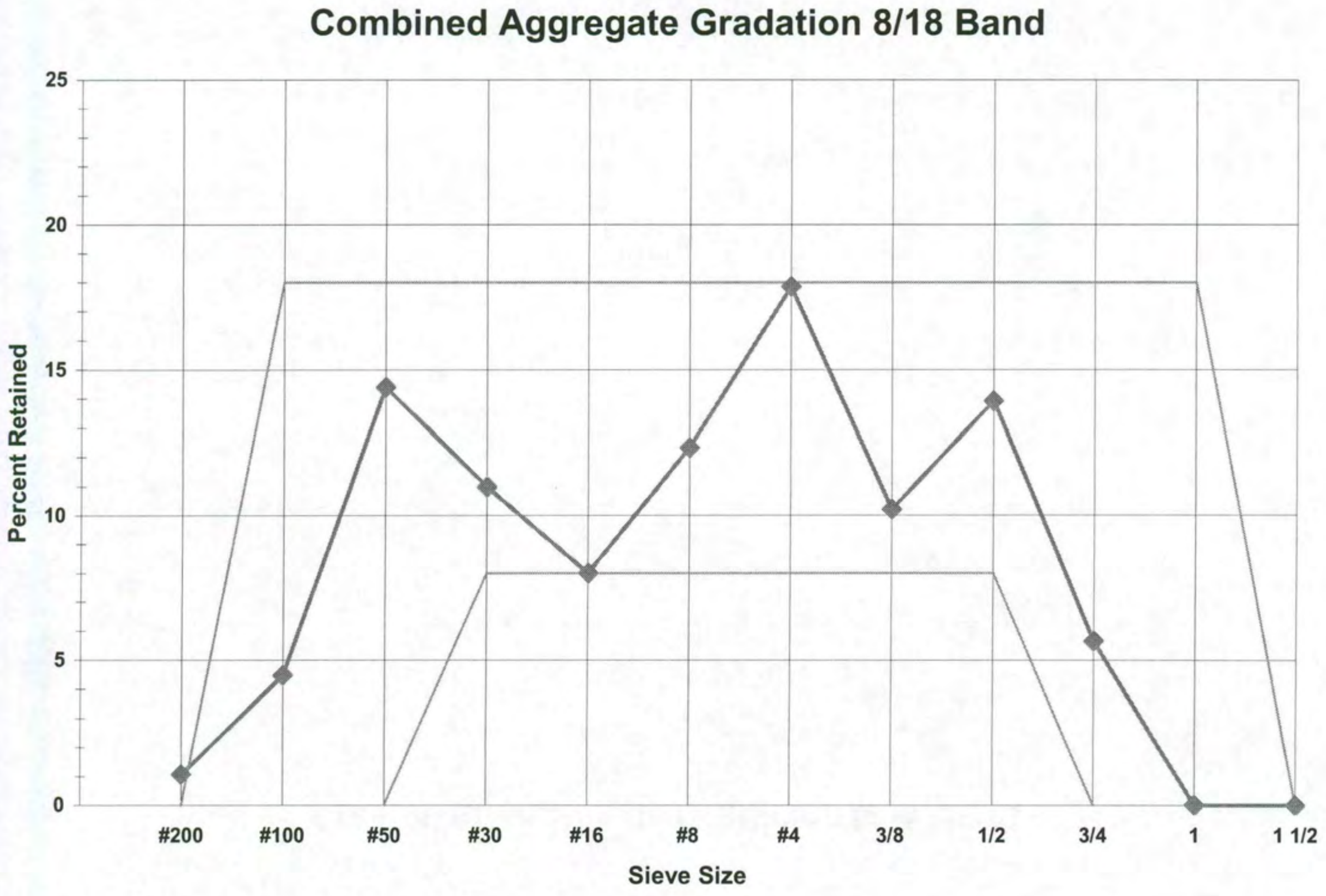
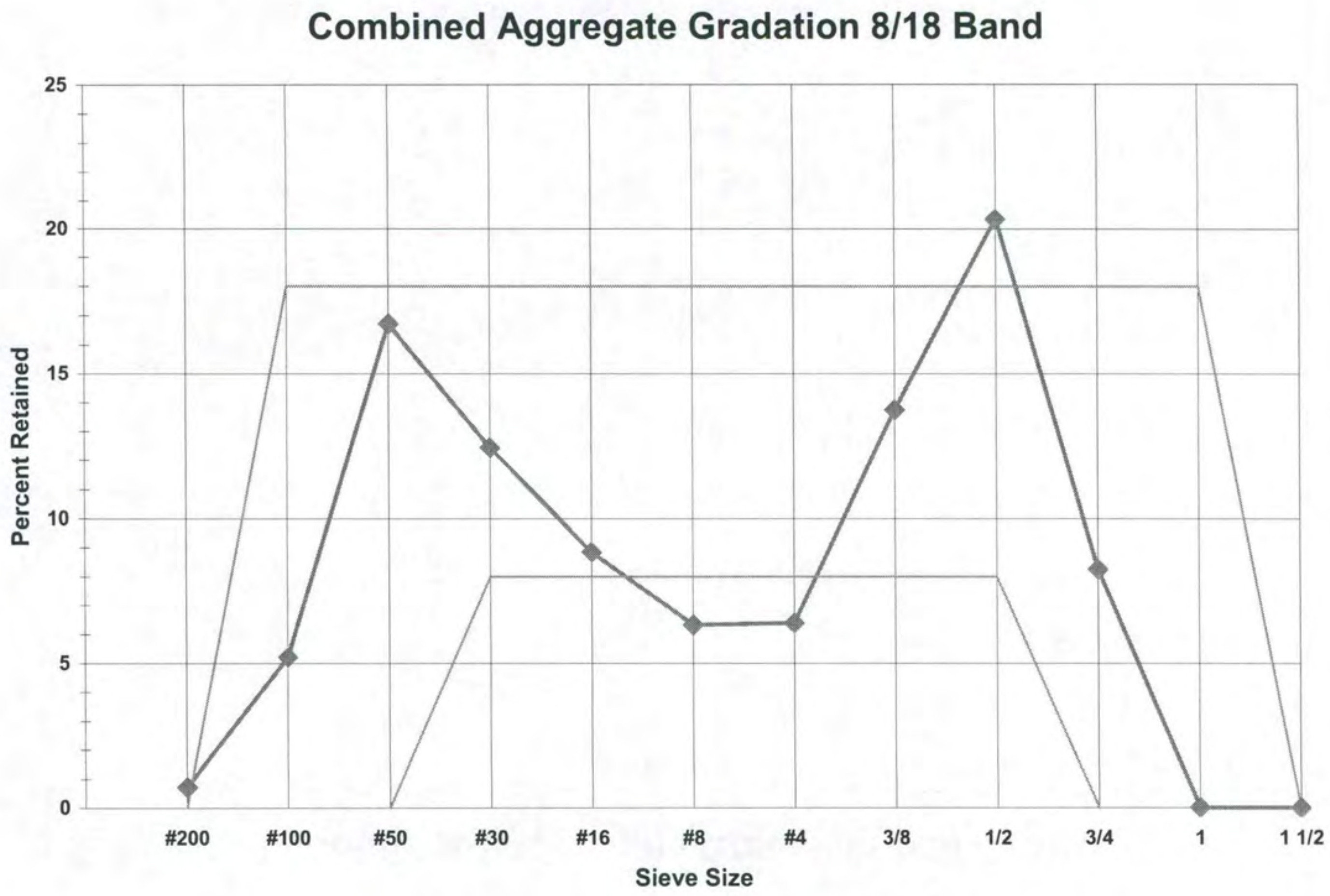

Combined Aggregate Gradation 8/18 Band
Percent Retained
25
20
15
10
5
0
#200
#100
#50
#30
#16
#8
#4
3/8
1/2
3/4
1
1 1/2
Sieve Size

FIGURE 5


Combined Aggregate Gradation 8/18 Band
Percent Retained
25
20
15
10
5
0
#200
#100
#50
#30
#16
#8
#4
3/8
1/2
3/4
1
1 1/2
Sieve Size

******THIS IS A NEW APPENDIX. – PLEASE READ CAREFULLY.******

Form 955QMC

Iowa Department of Transportation

Highway Division - Office of Materials
Proportion & Production Limits For Aggregates

County:
Project No.:
Date:
Project Location:
Mix Design No.:

Contractor:

Material	Ident #	% in Mix	A #	Producer & Location
1 1/2 " Stone				
Intermediate				
Conc. Sand				

Individual Aggregates Sieve Analysis - % Passing (Target)

Material	1 1/2 "	1"	3/4"	1/2"	3/8"	#4	#8	#16	#30	#50	#100	#200
1 1/2 " Stone												
Intermediate												
Conc. Sand												

Preliminary Target Gradation

* Upper Tolerance												
Comb Grading												
* Lower Tolerance												

Production Limits for Aggregates Approved by the Contractor & Producer.

	Coarse		Intermediate		
Sieve Size in.	1 1/2 " Stone 0.0%		Intermediate 0.0%		
	Max.	Min	Max.	Min.	
1 1/2					
1					
3/4					
1/2					
3/8					
#4					
#8					
#200	1.5	0.0			

	Fine Aggregate		
Sieve Size in.	Conc. Sand 0.0%		
	Max.	Min.	
3/8	100.0	100.0	
#4			
#8			
#16			
#30			
#50			
#100			
#200	1.5	0.0	

Comments: ____

____

The above target gradations and production limits have been discussed with and agreed to by an authorized representative of the aggregate producer.

Check (X)

Signed: ______________________ Producer
Coarse ☐
Interm. ☐
Signed: ______________________ Contractor

Signed: ______________________ Producer
Fine ☐
Signed: ______________________ Contractor

Iowa Department of Transportation

Office of Materials

October 16, 2007
Supersedes April 17, 2007

Matls. IM T203

GENERAL AGGREGATE SOURCE INFORMATION

GENERAL

Generally, only those sources, which have been sampled or tested within the last ten years, are listed. This listing additionally ranks sources in accordance with a frictional classification as defined herein for aggregates used in Hot Mix Asphalt (HMA) construction, and a durability class for coarse aggregates used in Portland Cement Concrete construction. Upon request, new sources or different combinations of beds within an existing source can be evaluated for classification for either type of use. These rankings do not in any way waive the normal quality requirements for the particular types of aggregates indicated in contract documents.

PORTLAND CEMENT CONCRETE AGGREGATES

Aggregates shall be produced from sources approved in accordance with the requirements of Office of Materials IM 409. The engineer may approve scalping of some portion of the coarser fraction.

All aggregates produced and inspected for intended use in contracts under Iowa Department of Transportation Specifications shall be stored in identifiable stockpiles unless they are being delivered as produced.

DURABILITY CLASSIFICATION

The coarse aggregates have been divided into three classes in accordance with their durability level as determined by performance or laboratory testing.

Class 2 durability aggregates will produce no deterioration of pavements of the non-interstate segments of the road system after 15 years and only minimal deterioration in pavements after 20 years.

Class 3 durability aggregates will produce no deterioration of pavements of non-interstate segments of the road system after 20 years of age and less than 5% deterioration of the joints after 25 years.

Class 3i durability aggregates will produce no deterioration of the interstate road system after 30 years of service and less than 5% deterioration of the joints after 35 years.

NOTE: Those sources with a "B" in their durability class designation may have 1/2 in. Bridge Deck Overlay/Repair material available.

HOT MIX ASPHALT AGGREGATES

Aggregates for HMA construction have been classified into five main functional types in accordance with their frictional characteristics. Those aggregates with the potential to develop the greatest amount of friction under traffic conditions are classified as Type 1 with the potential for friction decreasing as the type number increases. One or more friction types may be specified for use in pavement surface courses. If a type is not specified in the contract documents, Type 5 or better will be acceptable.

When aggregates of friction Type 1 through Type 4 are specified for construction, a source approval including bed limitations is required for each project. Tentative bed limitations are shown in this publication.

The frictional classification types are listed and defined in order of descending quality as follows.

Type 1: Aggregates, which are generally, a heterogeneous combination of minerals with coarse-grained microstructure of very hard particles (generally, a Mohs hardness range of 7 to 9) bonded together by a slightly softer matrix. These aggregates are typified by those developed for and used by the grinding-wheel industry such as calcinated bauxite (synthetic) and emery (natural). They are not available from Iowa sources. Due to their high cost, these aggregates would be specified only for use in extremely critical situations.

Type 2: Natural aggregates in this class are crushed quartzite and granites. The mineral grains in these materials generally have a Mohs hardness range of 5 to 7. Synthetic aggregates in this class are some air-cooled steel furnace slags and others with similar characteristics.

Type 3: Natural aggregates in this class are crushed traprocks, and/or crushed gravels. The crushed gravels shall contain 40% or more igneous and metamorphic particles. Synthetic aggregates in this class are the expanded shales with a Los Angeles abrasion loss less than 35 percent.

Type 4: Aggregates crushed from dolomitic or limestone ledges in which 80 percent of the grains are 20 microns or larger. The mineral grains in the approved ledges for this classification generally have a Mohs hardness range of 3 to 4. For natural gravels, the Type 5 carbonate (see below) particles, as a fraction of the total material, shall not exceed the non-carbonate particles by more than 20 percent.

The Friction Type 4D classification will no longer be a Friction designation. Friction Type 4D aggregates have been reclassified as Friction Type 5. Any source or bed combination can be reevaluated for a different Friction Classification by the Geology Section at the request of the Aggregate Producer.

Type 5: Aggregates crushed from dolomitic or limestone ledges in which 20 percent or more of the grains are 30 microns or smaller.

SOURCE LISTINGS - Explanation

The use of Xs in the PCC or HMA columns indicates use where no classification is required or, if required, has not been made.

NOTE: - indicates additional source restrictions.

Bed numbers shown for PCC aggregate are those on the formal source approval letter. Beds shown for HMA sources are those which have been used or have potential for use and are of the designated friction type.

Frictional Classification - as indicated on page 2
Hot Mix Asphalt - Type A and B

Durability Class for Portland Cement Concrete
Coarse Aggregate Fine Aggregate
("B" indicates acceptability for Bridge Deck Overlay/Repair)

Source Code Number - Used to identify sources on test requests and for data storage.

Specific Gravity
(DWU-Determine When Used)

CODE	OPERATOR	SOURCE NAME	LOCATION				BULK SSD SpGr	DUR PCC		FRICT HMA		BEDS	NOTE
								CA	FA	A	B		
29	**DES MOINES DIST 5**	**CRUSHED STONE**											
A29002	L&W QUARRIES INC	MEDIAPOLIS-LEONARD	SE	01	TO71	R04W	2.65	3				15	1
										4	4	15- 18	
										5	5	20	
A29008	CESSFORD CONST CO	NELSON	NE	26	TO72	R02W	2.62	3				21- 24	
										4	4	7- 20	
											4	15- 24	
										5	5	24- 27	
A29012	CESSFORD CONST CO	GEODE	NE	01	TO69	R05W				4	4	11- 12	
										5	5	9- 13	
		SAND & GRAVEL											
A29502	CESSFORD CONST CO	SPRING GROVE	SW	36	TO69	R03W		3		4	4		
							2.66		X				

NOTE 1: AASHTO 57 GRADATION MAXIMUM

RECENTLY ACTIVE AGGREGATE SOURCES

CODE	OPERATOR	SOURCE NAME	LOCATION				BULK SSD SpGr	DUR PCC CA	FA	FRICT HMA A	B	BEDS	T E
01	**ADAIR DIST 4**	**CRUSHED STONE**											
A01002	SCHILDBERG CONST CO INC	MENLO	SE	17	TO77	R31W				5	5	15 - 16	
											4	14	
A01006	SCHILDBERG CONST CO INC	HOWE	SW	01	TO76	R31W					5	25	
A01008	SCHILDBERG CONST CO INC	JEFFERSON	NE	17	TO77	R31W					5	20	
											5	25	
02	**ADAMS DIST 4**	**CRUSHED STONE**											
A02002	SCHILDBERG CONST CO INC	MT ETNA	SW	23	TO73	R34W					4	11 - 13	
A02004	SCHILDBERG CONST CO INC	CORNING		10	TO71	R34W					4	3 - 5	
		SAND & GRAVEL											
A02502	SCHILDBERG CONST CO INC	MT ETNA	NW	23	TO73	R34W	2.67	2		4	4		
							2.67		X				
03	**ALLAMAKEE DIST 2**	**CRUSHED STONE**											
A03002	BRUENING ROCK PROD INC	WEXFORD	NE	36	TO98	R03W	2.70	3i				1C - 5	
										4	4	1 - 8	
A03008	BRUENING ROCK PROD INC	MCCABE	NE	06	TO97	R05W					4	1 - 6	
A03010	ROVERUD CONST INC	RUDE	SE	17	T100	R06W							
A03014	BRUENING ROCK PROD INC	HAMMELL-BOONIES	SW	02	TO99	R06W		X		4	4	5 - 6	
A03018	ROVERUD CONST INC	SWENSON	SW	17	TO96	R05W							
A03022	ROVERUD CONST INC	LIVINGOOD	SW	07	TO96	R06W				4	4	4 - 7	
											4	2 - 7	
A03028	ROVERUD CONST INC	WELPER-JOHNSON	SW	35	TO99	R04W							
A03034	RIEHM CONST CO INC	WILDE	SE	13	TO99	R05W		X		4	4	1 - 5	
A03036	BRUENING ROCK PROD INC	SWENSON	SE	19	TO96	R05W							
A03038	RIEHM CONST CO INC	RIEHM	SE	07	T100	R04W	DWU	3i		4	4	1 - 4	
A03040	BRUENING ROCK PROD INC	DEE	SE	21	TO99	R04W	DWU	3iB		4	4	5A - 5D	
A03042	NIEMANN CONST CO	CHURCHTOWN	SW	29	TO99	R04W					4	1 - 3	
										4	4	3	
A03046	BRUENING ROCK PROD INC	MOHS	SW	29	TO96	R04W	DWU	2		5	5	1 - 2	
											5	1 - 4	
A03048	BRUENING ROCK PROD INC	POSTVILLE	SW	16	TO96	R06W	2.61	3				6 - 8	
											4	2 - 5	
A03050	BRUENING ROCK PROD INC	GREEN	NW	16	TO96	R06W	2.63	3		4	4	2 - 3A	
A03052	BRUENING ROCK PROD INC	ROSSVILLE	NE	35	TO97	R05W	DWU			4	4	1 - 5	
A03054	BRUENING ROCK PROD INC	WEST RIDGE	NE	08	TO98	R06W							
A03056	NIEMANN CONST CO	WAUKON	SW	05	TO97	R05W							
A03060	NIEMANN CONST CO	HANOVER	NE	36	TO99	R06W							
A03064	ROVERUD CONST INC	RAINBOW	SE	26	TO97	R05W							
A03066	WILTGEN CONST CO	ELSBERND	NW	29	TO97	R06W	DWU	3				2	
A03068	WILTGEN CONST CO	JEFFERSON	SW	30	TO97	R05W							
		SAND & GRAVEL											
A03502	CARLSON MATERIALS CO	HARPERS FERRY	SW	07	TO97	R02W	2.67	3iB		3	3		
							2.67		X				
A03506	BRUENING ROCK PROD INC	HAMMELL-BOONIES	SW	02	TO99	R06W				4	4		
A03510	CARLSON MATERIALS CO	LONNING	SE	02	TO99	R06W				4	4		
							DWU		X				
A03512	ROVERUD CONST INC	ZEZULKA	NE	11	T100	R04W				3	3		
							2.66		X				
A03516	ROVERUD CONST INC	HAMMELL	NW	15	T100	R03W							

RECENTLY ACTIVE AGGREGATE SOURCES

CODE	OPERATOR	SOURCE NAME	LOCATION				BULK SSD SpGr	DUR PCC CA	FA	FRICT HMA A	B	BEDS	NOTE
04	**APPANOOSE DIST 5**	**CRUSHED STONE**											
A04016	L&W QUARRIES INC	LEMLEY EAST #5	CT	35	TO70	R19W	2.70	2		5	5	1 - 3	1
										5	5	6	
A04018	L&W QUARRIES INC	CLARKDALE #8	SE	15	TO69	R18W					5	4	
05	**AUDUBON DIST 4**	**SAND & GRAVEL**											
A05506	HALLETT MATERIALS CO	EXIRA	SW	08	TO78	R35W	2.68	3		4	4		
							2.66		X				
06	**BENTON DIST 6**	**CRUSHED STONE**											
A06002	BMC AGGREGATES LC	SMITH	NW	19	TO86	R12W	2.65	2		4	4	21 - 26	
A06004	WENDLING QUARRIES INC	GARRISON A	SE	28	TO85	R11W	2.67	2		4	4	6 - 16	
A06006	WENDLING QUARRIES INC	GARRISON B	NE	33	TO85	R11W	2.64	2		4	4	6 - 16	
A06008	WENDLING QUARRIES INC	BALLHEIM	NE	17	TO86	R12W					X		
A06012	COOTS MATERIALS CO INC	JABENS	SW	07	TO85	R11W	DWU	2				6 - 11	
							2.63	2		4	4	12	
										4	4	10 - 12	
A06014	WENDLING QUARRIES INC	VINTON-MILROY	S2	10	TO85	R10W					4		
A06016	COOTS MATERIALS CO INC	COOTS	SW	36	TO86	R11W					X		
A06018	WENDLING QUARRIES INC	PORK CHOP-EAST	NW	11	TO85	R09W					X		
A06020	WENDLING QUARRIES INC	PORK CHOP-WEST	NE	10	TO85	R09W							
A06022	WENDLING QUARRIES INC	LONG	SE	13	TO84	R09W					X		
		SAND & GRAVEL											
A06502	WENDLING QUARRIES INC	VINTON-MILROY	S2	10	TO85	R10W				4	4		
							2.65		X				
06504	COOTS MATERIALS CO INC	MT AUBURN	SW	31	TO86	R10W				3	3		
							2.65		X				
A06506	WENDLING QUARRIES INC	PORK CHOP	CT	11	TO85	R09W				4	4		
							DWU		X				
07	**BLACK HAWK DIST 2**	**CRUSHED STONE**											
A07004	BMC AGGREGATES LC	WATERLOO SOUTH	NW	18	TO87	R12W	DWU	3				25	
										4	4	17 - 24	
										4	4	32 - 36	
										5	5	5 - 24	
A07008	BMC AGGREGATES LC	MORGAN	NE	15	TO89	R12W					5	1 - 3	
											5	4A - 4B	
A07014	NIEMANN CONST CO	GLORY	NE	36	TO87	R11W					4	3 - 4	
											5	1 - 4	
A07018	BMC AGGREGATES LC	RAYMOND-PESKE	SW	01	TO88	R12W	2.66	2		4	4	1B - 5	
										4	4	6 - 10	
A07020	BMC AGGREGATES LC	STEINBRON	SE	01	TO88	R11W	2.62	3i		X	X	1	
A07022	BMC AGGREGATES LC	MESSERLY	NE	08	TO90	R14W							
		SAND & GRAVEL											
A07504	BMC AGGREGATES LC	WATERLOO SAND	SW	09	TO89	R13W				3	3		
							2.65		X				
A07506	MANATT'S INC	ASPRO	NW	01	TO88	R13W				4	4		
							2.65		X				
A07508	BMC AGGREGATES LC	GILBERTVILLE		16	TO88	R12W				4	4		
							2.65		X				
A07512	ZEIEN S&G	ZEIEN	NW	23	TO87	R12W							
A07518	NIEMANN CONST CO	JANESVILLE	NE	14	TO90	R14W				3	3		
							2.66		X				

NOTE: 1 – AASHTO 67, GRADATION #5, 40% MAXIMUM; RESTRICTION DOES NOT APPLY TO STRUCTURAL CONCRETE

RECENTLY ACTIVE AGGREGATE SOURCES

CODE	OPERATOR		SOURCE NAME	LOCATION				BULK SSD SpGr	DUR PCC CA	FA	FRICT HMA A	B	BEDS	T E
08	**BOONE**	**DIST 1**	**SAND & GRAVEL**											
A08504	KNIFE RIVER		JENSEN	SW	36	TO85	R25W							
A08526	KNIFE RIVER		POWERS		29	TO84	R28W							
09	**BREMER**	**DIST 2**	**CRUSHED STONE**											
A09002	BMC AGGREGATES LC		FREDERIKA	NE	12	TO93	R13W					5	2 - 8	
A09004	NIEMANN CONST CO		DENVER-FOELSKE	NE	29	TO91	R13W				4	4	4 - 9	
A09006	NIEMANN CONST CO		TRIPOLI-PLATTE	SW	36	TO93	R13W	2.62	3i		4	4	1 - 5	
A09008	NIEMANN CONST CO		DENVER #2	NE	20	TO91	R13W							
			SAND & GRAVEL											
A09504	NIEMANN CONST CO		NOLTE	SE	31	TO92	R11W				4	4		
								2.65		X				
A09508	NIEMANN CONST CO		TRIPOLI-PLATTE	SW	36	TO93	R13W							
A09510	CROELL REDI-MIX		PLAINFIELD-ADAMS	NE	32	TO93	R14W	2.66		X				
A09512	NIEMANN CONST CO		BOEVERS	NE	31	TO92	R11W			X				
10	**BUCHANAN**	**DIST 6**	**CRUSHED STONE**											
A10002	NIEMANN CONST CO		WESTON-LAMONT	NW	14	TO90	R07W	2.61	3iB				1 - 6	
											4	4	1 - 7	
A10004	NIEMANN CONST CO		BLOOM-JESUP	SW	32	TO89	R10W	2.63	3				2 - 5	
											4	4	1 - 7	
A10008	BRUENING ROCK PROD INC		OELWEIN	NW	02	TO90	R09W	2.65	3i		4	4	4 - 5	
											4	4	4 - 6	
A10010	NIEMANN CONST CO		HAZELTON	NW	11	TO90	R09W	2.60	3iB		4	4	4	
A10012	NIEMANN CONST CO		INDEPENDENCE	NW	14	TO88	R09W					5		
A10014	NIEMANN CONST CO		OELWEIN #1	SW	02	TO90	R09W				5	5	1 - 12	
A10016	NIEMANN CONST CO		OELWEIN #2	SE	03	TO90	R09W	DWU	3i		4	4	13 - 16	
A10018	NIEMANN CONST CO		EAST AURORA	SE	17	TO90	R07W				4	4	1 - 5	
A10022	BRUENING ROCK PROD INC		BROOKS	NW	02	TO88	R09W	2.60	3i		4	4	7	
												5	1 - 6	
A10024	NIEMANN CONST CO		RASMUSSEN #2	SE	21	TO88	R08W					5		
A10026	NIEMANN CONST CO		BRANDON	SE	27	TO87	R10W					5		
A10028	NIEMANN CONST CO		HERTZBERGER	NE	36	TO87	R10W					5		
A10030	NIEMANN CONST CO		SOUTH AURORA	NW	19	TO90	R07W	2.62	3iB			4	1 - 3	
A10032	NIEMANN CONST CO		SELLS	NW	25	TO88	R09W					5		
A10034	NIEMANN CONST CO		TROY MILLS	SE	30	TO87	R07W							
A10036	WENDLING QUARRIES INC		KILER	NW	34	TO87	R10W					4		
A10038	BMC AGGREGATES LC		WIDGER	SW	07	TO88	R10W	2.61	3i				1B	
											4	4	1A - 1B	
A10040	ZUPKE SAND & GRAVEL		ZUPKE-OELWEIN		09	TO90	R09W							
			SAND & GRAVEL											
A10504	NIEMANN CONST CO		WARD	NE	14	TO90	R07W				4	4		
								2.65		X				
A10506	MANATT'S INC		GREENLEY	SE	29	TO89	R09W				4	4		
								2.64		X				
A10510	NIEMANN CONST CO		HUFFMAN	SE	02	TO89	R08W				4	4		
								2.65		X				
A10514	NIEMANN CONST CO		HOLLERMAN	SE	26	TO90	R07W				4	4		
A10516	NIEMANN CONST CO		MILLER	NW	14	TO88	R09W	2.65		X				
A10518	MANATT'S INC		YEAROUS	SE	19	TO89	R09W	2.65		X				
A10520	BRUENING ROCK PROD INC		BROOKS	SW	02	TO88	R09W							

RECENTLY ACTIVE AGGREGATE SOURCES

CODE	OPERATOR	SOURCE NAME	LOCATION				BULK SSD SpGr	DUR PCC CA	FA	FRICT HMA A	B	BEDS	NOTE
11	**BUENA VISTA DIST 3**	**SAND & GRAVEL**											
A11502	ROHLIN CONST CO INC	ROHLIN	SW	02	TO93	R38W				4	4		
A11504	MARTIN MARIETTA	RAILROAD	NE	03	TO93	R37W				3	3		
A11506	MARTIN MARIETTA	LINN GROVE	NW	25	TO93	R38W				4	4		
A11508	WETHERALL CONST CO	NEWELL	NW	01	TO90	R36W				4	4		
A11510	MARTIN MARIETTA	SIOUX RAPIDS		05	TO93	R36W				3	3		
A11512	BUENA VISTA COUNTY	MARATHON	SE	19	TO93	R35W				4	4		
A11514	LUNDELL CONST	STORM LAKE	SW	18	TO90	R36W				4	4		
A11516	HALLETT MATERIALS CO	SIOUX RAPIDS	W2	12	TO93	R37W				3	3		
A11518	KNIFE RIVER	MOLGAARD	NW	03	TO93	R38W							
12	**BUTLER DIST 2**	**CRUSHED STONE**											
A12004	GREENE LS CO	LUBBEN	NW	25	TO93	R17W					5	1 - 21	
A12008	GREENE LS CO	FLORRY-STEERE	CT	08	TO93	R17W					5	1 - 11	
A12010	CARLSON/BRUENING	CLARKSVILLE-ENGLE	NE	16	TO92	R15W							
A12014	NIEMANN CONST CO	OLTMANN	SE	08	TO91	R16W					X		
A12016	GREENE LS CO	WIEGMANN-BRISTOW	SE	23	TO92	R18W				X	X	1 - 11	
A12018	GREENE LS CO	NEYMEYER	SW	28	TO90	R18W							
A12020	GREENE LS CO	BRUNS #2	NW	21	TO91	R18W							
		SAND & GRAVEL											
A12502	CROELL REDI-MIX	CLARKSVILLE	NW	01	TO92	R16W	2.67	2		4	4		
							2.67		X				
A12504	SHELL ROCK S&G	BROOKS	NE	02	TO91	R15W	2.66	X		4	4		
							2.67		X				
A12508	GREENE LS CO	AUSTINVILLE	NW	23	TO90	R18W	2.64		X	3	3		
A12514	GREENE LS CO	DE VRIES	SW	28	TO90	R18W				4	4		
							2.63		X				
A12516	GREENE LS CO	JENSEN	S2	18	TO93	R16W				4	4		
A12518	NIEMANN CONST CO	SHELL ROCK-ADAMS	NE	03	TO91	R15W				3	3		
							2.66		X				
13	**CALHOUN DIST 3**	**SAND & GRAVEL**											
A13502	KNIFE RIVER	LAKE CITY	NE	26	TO86	R34W				4	4		
14	**CARROLL DIST 3**	**SAND & GRAVEL**											
A14506	MARTIN MARIETTA	POUND	SE	18	TO85	R33W				4	4		
A14510	TIEFENTHALER INC	LANESBORO	NW	17	TO85	R33W	2.72	2		4	4		
							2.68		X				
A14512	MARTIN MARIETTA	OPEN	SE	15	TO84	R34W				4	4		
A14514	TIEFENTHALER INC	MACKE		06	TO85	R33W	2.69	2		4	4		
							2.66		X				
A14516	KNIFE RIVER	RICHLAND	NE	23	TO83	R33W				4	4		
15	**CASS DIST 4**	**CRUSHED STONE**											
A15004	SCHILDBERG CONST CO INC	LEWIS	SE	17	TO75	R37W					4	10 - 11	
A15008	SCHILDBERG CONST CO INC	ATLANTIC MINE	NE	13	TO76	R37W					5	25	

RECENTLY ACTIVE AGGREGATE SOURCES

CODE	OPERATOR	SOURCE NAME	LOCATION				BULK SSD SpGr	DUR PCC CA	FA	FRICT HMA A	B	BEDS	T E
16	**CEDAR DIST 6**	**CRUSHED STONE**											
A16002	WENDLING QUARRIES INC	HUNT	SW	10	TO81	R04W	DWU	3iB		4	4	1	
A16004	WENDLING QUARRIES INC	LOWDEN-SCHNECKLOTH	NW	04	TO81	R01W	DWU	3i				1	
										4	4	1 - 3	
A16006	WENDLING QUARRIES INC	STONEMILL	SE	14	TO80	R03W	DWU	3iB		4	4	4	
A16010	WENDLING QUARRIES INC	PEDEN	NE	10	TO79	R03W				5	5		
A16012	WEBER STONE CO INC	ONION GROVE	SE	14	TO82	R02W	2.61	3i		4	4	1 - 7	
A16014	WENDLING QUARRIES INC	TOWNSEND	NW	02	TO79	R02W							
A16018	WENDLING QUARRIES INC	LOWDEN-MASSILLON	NW	23	TO82	R01W							
A16022	WENDLING QUARRIES INC	TRICON	N2	09	TO82	R04W	DWU	3i		4	4	1	
		SAND & GRAVEL											
A16502	WENDLING QUARRIES INC	SHARPLISS	NW	12	TO79	R03W				4	4		
							2.65		X				
A16506	WEBER STONE CO INC	ONION GROVE	SE	14	TO82	R02W	2.65		X				
A16508	WENDLING QUARRIES INC	MASSILLON	CT	11	TO82	R01W	2.65		X				
17	**CERRO GORDO DIST 2**	**CRUSHED STONE**											
A17008	MARTIN MARIETTA	PORTLAND WEST	NE	19	TO96	R19W	2.75	3iB		4	4	1 - 8	
A17012	MARTIN MARIETTA	UBBEN	SW	26	TO94	R20W	2.68	2				3	
										5	5	1 - 3	
A17020	MARTIN MARIETTA	MASON CITY	NE	29	TO97	R20W	DWU	3i				7	
							2.73	3				7 - 9	
										4	4	8 - 9	
										X	X	1 - 6	
A17022	HOLCIM INC	HOLCIM	SE	19	TO97	R20W	DWU	2				1 - 4	
							DWU	2				11 - 13	
A17024	HEARTLAND ASPHALT	RIVERVIEW	NE	29	TO96	R19W				4	4	1 - 12	
		SAND & GRAVEL											
A17506	KNIFE RIVER	NELSON-FORBES	SW	27	TO96	R19W				4	4		
A17512	NORTH IOWA S&G INC	WEPKING	NE	15	TO97	R21W	DWU		X	3	3		
A17514	MARTIN MARIETTA	HOLCIM SAND	NE	19	TO97	R20W	DWU	2		3	3		
							2.65		X				
A17518	HEARTLAND ASPHALT	AIRPORT	NE	08	TO96	R21W				3	3		
18	**CHEROKEE DIST 3**	**SAND & GRAVEL**											
A18506	HALLETT MATERIALS CO	CHEROKEE SOUTH	NE	16	TO91	R40W	2.70	2		3	3		
							2.69		X				
A18512	FABER & SON CONST CO	KILLIAM	SW	20	TO93	R39W				4	4		
A18514	HIGMAN SAND & GRAVEL	MONTGOMERY	NE2	20	TO93	R39W				4	4		
A18516	MARTIN MARIETTA	WASHTA #1	NE	30	TO90	R41W				3	3		
A18518	MARTIN MARIETTA	QUIMBY	SW	15	TO90	R41W				3	3		
A18520	MARTIN MARIETTA	QUIMBY-EAST	NW	06	TO90	R40W				3	3		
A18526	HALLETT MATERIALS CO	CHEROKEE NORTH	SW	23	TO92	R40W	2.70	2		3	3		
							2.67		X				
A18528	HIGMAN SAND & GRAVEL	WASHTA-BEAZLEY	SW	31	TO90	R41W	DWU		X	3	3		
A18530	HIGMAN SAND & GRAVEL	PATTERSON		32	TO91	R40W	2.69	2					
							DWU		X				
A18532	CHEROKEE COUNTY	WALKER		31	TO90	R41W							
A18534	HALLETT MATERIALS CO	NELSON	CT	23	TO92	R40W	2.67	2					
							2.68		X				
A18536	HIGMAN SAND & GRAVEL	BECK	NE	30	TO93	R39W	DWU	2					
									X				

RECENTLY ACTIVE AGGREGATE SOURCES

CODE	OPERATOR	SOURCE NAME	LOCATION				BULK SSD SpGr	DUR PCC CA	FA	FRICT HMA A	B	BEDS	NOTE
19	**CHICKASAW DIST 2**	**CRUSHED STONE**											
A19002	GREENE LS CO	TRACY	SE	29	T094	R14W	2.55	2		4	4	9 - 10	
A19004	BRUENING ROCK PROD INC	DEERFIELD-MAHONEY	SE	33	T097	R14W					X		
A19006	GREENE LS CO	HUNT	NE	29	T094	R14W	2.57	2		4	4	9 - 10	
A19008	GREENE LS CO	BOICE	NE	16	T095	R14W					5		
		SAND & GRAVEL											
A19504	GREENE LS CO	HUNT	NW	29	T094	R14W				4	4		
A19506	BLAZEK S&G CO	BLAZEK	NW	32	T096	R11W				4	4		
							2.66		X				
A19508	ROVERUD CONST INC	BUSTA	SE	23	T096	R11W				4	4		
							2.65		X				
A19510	RIVER BEND ENTERPRISES	NASHUA	NE	31	T094	R14W				X	X		
							2.66		X				
A19512	GREENE LS CO	PEARL ROCK	SE	31	T094	R14W				4	4		
							2.65		X				
A19514	BRUENING ROCK PROD INC	NASHUA	SW	33	T095	R14W	DWU		X				
A19516	NIEMANN CONST CO	REWOLDT	NE	25	T094	R13W	2.64		X				
A19518	CARLSON MATERIALS CO	AGGLAND		31	T096	R12W	2.64		X				
A19520	WILTGEN CONST CO	ROFONKE	NE SE	16	T095	R14W							
A19522	CROELL REDI MIX	BUCKY'S	NW	03	T095	R11W	2.65		X				
20	**CLARKE DIST 5**	**CRUSHED STONE**											
A20002	SCHILDBERG CONST CO INC	OSCEOLA	NW	12	T072	R26W					5	1 - 10	
											X	1 - 4	1
21	**CLAY DIST 3**	**SAND & GRAVEL**											
21506	DAVE'S S&G	EVERLY	SW	31	T097	R38W	2.70	2		3	3		
							2.68		X				
A21508	MARTIN MARIETTA	SCHARNBURG	NE	11	T096	R38W				4	4		
A21510	NORGAARD S&G	DICKENS	NW	20	T096	R35W				3	3		
							2.70		X				
A21514	MARTIN MARIETTA	CORNELL	SW	27	T094	R36W				4	4		
A21516	SIEH S&G	SPENCER #1	SW	24	T096	R36W	2.69	2		3	3		
							2.66		X				
A21518	HALLETT MATERIALS CO	SPENCER #2	SW	05	T097	R37W				4	4		
A21520	MARTIN MARIETTA	EVERLY	SE	06	T096	R38W				4	4		
A21522	KNIFE RIVER	STAINS		30	T097	R38W				4	4		
A21526	ROHLIN CONST CO INC	CLAY COUNTY	NW	20	T096	R35W							
A21528	DAVE'S S&G	GOEKEN	NE	05	T096	R38W	DWU	2					
A21530	ROHLIN CONST CO INC	BRAUNSCHWEIG		16	T094	R36W							
A21532	CLAY COUNTY	ELSER	CT	03	T094	R36W							
A21534	HALLETT MATERIALS CO	CLARK EVERLY	NW	06	T096	R38W							
A21536	HALLETT MATERIALS CO	GILLETT GROVE	NE	03	T094	R36W							
22	**CLAYTON DIST 2**	**CRUSHED STONE**											
A22002	KUHLMAN CONST CO	TWIN ROCK-SCHRADER	NW	14	T094	R05W				4	4	1 - 11	
										4	4	3 - 11	
A22004	ROVERUD CONST INC	BENTE-ELKADER-WATSON	SW	12	T093	R05W	2.66	2				6 - 9	
										4	4	1 - 9	
A22006	BRUENING ROCK PROD INC	MARQUETTE	NW	16	T095	R03W	DWU	3i		4	4	1 - 3	
A22008	KUHLMAN CONST CO	ANDEREGG	SE	32	T092	R02W	DWU			4	4	2 - 8	
A22010	KUHLMAN CONST CO	OSTERDOCK	SE	02	T091	R03W	2.67	2				2 - 5	
										4	4	1 - 8	
A22012	KUHLMAN CONST CO	SCHMIDT	NE	33	T091	R01W	2.66	3i				4B - 6	
										4	4	2 - 6	
A22014	ROVERUD CONST INC	BLUME	NE	09	T093	R03W	2.64	2				1 - 7	
										4	4	1 - 12	

NOTE: 1 – FRICTION TYPE TO BE DETERMINED WHEN USED ON WINTERSET BEDS 1-4

RECENTLY ACTIVE AGGREGATE SOURCES

CODE	OPERATOR	SOURCE NAME	LOCATION				BULK SSD SpGr	DUR PCC CA	FA	FRICT HMA A	B	BEDS	T E
22	**CLAYTON DIST 2**	**CRUSHED STONE**											
A22016	KUHLMAN CONST CO	GISLESON	NW	06	TO95	R04W	2.66	3i		4	4	1 - 8	
										4	4	1 - 15	
A22018	ROVERUD CONST INC	ZURCHER	SE	01	TO94	R05W				4	4		
A22020	KUHLMAN CONST CO	MUELLER	NE	30	TO94	R03W	DWU	3i		4	4	1 - 8	
A22024	MIELKE'S QUARRY	SPOOK CAVE	NE	21	TO95	R04W				4	4	1 - 2	
A22026	KUHLMAN CONST CO	DOERRING-LUANA	SE	05	TO95	R05W					4		
A22030	KUHLMAN CONST CO	EBERHARDT	NW	27	TO93	R05W	2.72	3		4	4	1 - 5	
											4	1 - 8	
A22032	KUHLMAN CONST CO	WELLMAN	NW	25	TO92	R06W		X		X	4	1 - 6	
A22034	KUHLMAN CONST CO	KRUSE	NW	17	TO92	R04W	2.70	3B		4	4	5 - 11	
							2.70	2B		4	4	5 - 12	
										4	4	2 - 12	
A22038	KUHLMAN CONST CO	FASSBINDER	SW	09	TO92	R03W	2.67	3i		4	4	2B - 6	
A22040	KUHLMAN CONST CO	HARTMAN	NW	29	TO91	R06W	2.68	3i		4	4	1 - 4	
A22042	ROVERUD CONST INC	MORAREND	CT	35	TO92	R03W	2.67	X				1 - 8	
										4	4	1 - 10	
A22044	KUHLMAN CONST CO	BOGE	SW	18	TO91	R02W							
A22046	KUHLMAN CONST CO	JOY SPRINGS-BURRACK	NW	19	TO91	R06W	2.65	3i		4	4	1	
A22048	ROVERUD CONST INC	TUCKER	SW	18	TO91	R05W							
A22056	ROVERUD CONST INC	MCGREGOR	NE	34	TO95	R03W					4		
A22058	ROVERUD CONST INC	ST OLAF	SE	25	TO94	R05W							
A22060	ROVERUD CONST INC	JOHNSON	NW	26	TO93	R04W	2.64	3i		4	4	2 - 5	
										4	4	1 - 5	
A22062	ROVERUD CONST INC	SNY MAGILL	SE	22	TO94	R03W	DWU	3i		4	4	6 - 10	
A22066	ROVERUD CONST INC	PETERSON	NW	09	TO94	R06W							
A22068	RIVER CITY STONE INC	MILLVILLE	NW	10	TO91	R02W	DWU	3i				1 - 8	
A22070	ROVERUD CONST INC	BERNHARD/GIARD	NW	35	TO95	R04W	DWU	3i		4	4	1 - 3	
A22072	PATTISON BROS	CLAYTON TERMINAL		07	TO93	R02W	DWU	3i		4	4	3 - 4	
								3		4	4	1	
A22074	RIVER CITY STONE INC	STRAWBERRY POINT	NE	19	TO91	R06W	DWU	3i				1 - 2	
A22076	ROVERUD CONST INC	LARSON	NW	08	TO93	R05W							
A22078	ROVERUD CONST INC	SMITH		07	TO93	R06W							
A22080	KUHLMAN CONST CO	HILINE	NW	08	TO91	R03W							
A22082	NIEMANN CONST CO	REIERSON	NW	20	TO94	R06W							
A22084	CJ MOYNA & SONS	MOYNA		14	TO93	R05W							
A22086	CJ MOYNA & SONS	WILLIE	SW	18	TO93	R02W							
A22088	WILTGEN CONST CO	KEPPLER	NW	29	TO94	R05W							
		SAND & GRAVEL											
A22510	ROVERUD CONST INC	BENTE	SE	15	TO93	R05W	2.66	X		4	4		
							2.66		X				
A22512	KUHLMAN CONST CO	FAIRGROUND	NE	26	TO93	R05W				4	4		
							2.66		X				
A22514	KUHLMAN CONST CO	JOY SPRINGS	SW	19	TO91	R06W				X	X		
A22518	KUHLMAN CONST CO	THURN	CT	25	TO92	R05W				3	3		
							2.65		X				
A22520	KUHLMAN CONST CO	WELTERLEN	SE	32	TO91	R05W	2.65		X				

RECENTLY ACTIVE AGGREGATE SOURCES

CODE	OPERATOR	SOURCE NAME	LOCATION				BULK SSD SpGr	DUR PCC CA	FA	FRICT HMA A	B	BEDS	NOTE
23	**CLINTON DIST 6**	**CRUSHED STONE**											
A23002	WENDLING QUARRIES INC	BLOORE-ELWOOD	NW	08	T083	R02E	DWU	3i		4	4	1 - 2	
A23004	WENDLING QUARRIES INC	BEHR	SW	02	T081	R03E	2.61	3i		4	4	1 - 2	
A23006	WENDLING QUARRIES INC	SHAFFTON	NE	11	T080	R05E	DWU	3i		4	4	16 - 17	
							DWU	3		4	4	3 - 14	
							DWU	3				19 - 20	
										4	4	3 - 15	
A23010	WENDLING QUARRIES INC	GOOSE LAKE	SW	22	T083	R05E				4	4	1 - 10	
A23012	WENDLING QUARRIES INC	TEEDS GROVE	SW	03	T083	R06E					4		
A23016	WENDLING QUARRIES INC	LYONS	NW	18	T082	R07E					4		
A23026	WENDLING QUARRIES INC	MILL CREEK	NE	22	T082	R06E					4		
A23028	WENDLING QUARRIES INC	DELMAR	SE	06	T083	R04E							
A23030	WENDLING QUARRIES INC	EDON VALLEY		04	T083	R01E							
A23032	ANDERSON S&G	ANDERSON		23	T081	R03E							
A23034	PRESTON READY MIX	TRANSTAR	NE	25	T081	R05E							
		SAND & GRAVEL											
A23502	WENDLING QUARRIES INC	DOYLE	NE	30	T083	R07E				4	4		
							2.67		X				
A23504	WENDLING QUARRIES INC	BEHR	SW	02	T081	R03E	2.68	2		4	4		
							2.68		X				
A23506	WENDLING QUARRIES INC	SCHNECKLOTH	S2	10	T080	R05E				4	4		
							2.67		X				
A23508	WENDLING QUARRIES INC	GATEWAY	NE	27	T081	R06E				4	4		
							2.66		X				
A23510	WENDLING QUARRIES INC	SHAFFTON	N2	11	T080	R05E				4	4		
							2.66		X				
A23514	ANDERSON S&G	ANDERSON	NW	23	T081	R03E	2.68		X				
A23516	WENDLING QUARRIES INC	OLSON	NW	23	T081	R02E							
24	**CRAWFORD DIST 3**	**SAND & GRAVEL**											
A24512	HALLETT MATERIALS CO	DUNLAP	SE	27	T082	R41W	2.70	2		3	3		
							2.66		X				
A24514	NATURAL MATERIALS	DENISON	SE	28	T084	R39W	DWU	2		3	3		
							DWU		X				
25	**DALLAS DIST 4**	**SAND & GRAVEL**											
A25502	HALLETT MATERIALS CO	MESSERSCHMIDT	NW	28	T079	R27W	2.70	2		4	4		
							2.67		X				
A25510	HALLETT MATERIALS CO	PERRY	NW	01	T081	R29W	2.70	2		4	4		
							2.67		X				
A25512	HALLETT MATERIALS CO	VAN METER	SE	16	T078	R27W	2.68	2		3	3		
							2.66		X				
A25514	HALLETT MATERIALS CO	BOONEVILLE	S2	26	T078	R26W	2.68	2		3	3		
							DWU		X				
A25516	HALLETT MATERIALS CO	VAN METER SOUTH		21,22	T078	R27W	2.68	2		3	3		
							2.66		X				
A25518	MARTIN MARIETTA	RACCOON RIVER SAND		27,28	T078	R26W	DWU	2					
							DWU		X				

RECENTLY ACTIVE AGGREGATE SOURCES

CODE	OPERATOR	SOURCE NAME	LOCATION					BULK SSD SpGr	DUR PCC CA	FA	FRICT HMA A	B	BEDS	TE
26	**DAVIS DIST 5**	**CRUSHED STONE**												
A26004	DOUDS STONE INC	LEWIS		W2	02	TO69	R12W	2.60	3		4	4	1	
											5	5	3 - 7	
												5	3 - 5	
											4	4	6 - 7	
A26006	DOUDS STONE INC	BROWN	SW	NW	02	TO69	R12W	2.60	3		4	4	1	
											5	5	3 - 7	
												5	3 - 5	
											4	4	6 - 7	
		SAND & GRAVEL												
A26502	DOUDS STONE INC	ELDON-FRANKLIN		SW	01	TO70	R12W	2.67		X				
27	**DECATUR DIST 5**	**CRUSHED STONE**												
A27002	SCHILDBERG CONST CO INC	GRAND RIVER		NW	22	TO70	R27W					5	12 - 14	
A27008	SCHILDBERG CONST CO INC	DECATUR		SE	32	TO69	R26W					X	7	1
												5	9 - 15	
28	**DELAWARE DIST 6**	**CRUSHED STONE**												
A28002	KUHLMAN CONST CO	SEDGEWICK #2		SW	36	TO90	R06W	2.66	3iB		4	4	3	
A28006	KUHLMAN CONST CO	SEDGEWICK #1		SW	36	TO90	R06W				4	4	1 - 3	
A28008	KUHLMAN CONST CO	EDGEWOOD WEST		CT	04	TO90	R05W	2.67	3i				2 - 7	
											4	4	1 - 7	
A28010	KUHLMAN CONST CO	TIBBOTT		SW	23	TO90	R04W	2.70	3i				1 - 5	
											4	4	1 - 7	
A28012	KUHLMAN CONST CO	BAUL		SE	22	TO89	R06W	2.69	3i		4	4	1 - 4	
A28014	KUHLMAN CONST CO	LOGAN		SW	10	TO88	R05W	2.69	3				2 - 8	
											4	4	1 - 8	
A28016	KUHLMAN CONST CO	WHITE		NW	02	TO88	R04W	2.72	3i		4	4	1 - 2	
A28020	BARD CONCRETE CO	DEUTMEYER		SW	13	TO88	R03W	DWU	3i		4	4	2 - 6	
A28030	KUHLMAN CONST CO	GRIEF		NE	18	TO87	R03W					4		
A28032	RIVER CITY STONE INC	SCHNITTJER-DELHI		NE	35	TO88	R04W							
A28038	KUHLMAN CONST CO	KUHLMAN		NW	06	TO90	R04W	2.70	3i		4	4	1B - 5	
A28040	BARD CONCRETE CO	KRAPFL		SE	23	TO89	R03W	2.69	3i		4	4	4	
											4	4	1 - 4	
A28042	KUHLMAN CONST CO	WALSTON-MASONVILLE		SE	21	TO89	R06W	2.69	3i				1 - 4	
											4	4	1 - 6	
A28044	NIEMANN CONST CO	DUNDEE		NE	20	TO90	R06W					4		
A28046	KUHLMAN CONST CO	PINS		NW	27	TO88	R03W							
A28050	KUHLMAN CONST CO	BUCK CREEK		NW	20	TO87	R04W							
A28052	RIVER CITY STONE INC	MANCHESTER		SW	09	TO88	R05W	DWU	3				5 - 8	
A28054	RIVER CITY STONE INC	WINCH	NW	SW	02	TO87	R04W							
A28056	RIVER CITY STONE INC	THORPE		NW	33	TO90	R05W							
A28058	RIVER CITY STONE INC	ROSSOW/MANCHESTER	NE	NW	16	TO88	R05W							
		SAND & GRAVEL												
A28502	KUHLMAN CONST CO	SEDGEWICK		SW	36	TO90	R06W				4	4		
								2.65		X				
A28504	BARD CONCRETE CO	TEGLER		NE	36	TO89	R03W				4	4		
								2.65		X				
A28506	BARD CONCRETE CO	DYERSVILLE		NW	26	TO89	R03W				4	4		
								2.65		X				
A28510	KUHLMAN CONST CO	LOGAN		SW	10	TO88	R05W	2.65		X				
A28514	KUHLMAN CONST CO	FERGESEN		NE	32	TO89	R06W				4	4		
								DWU		X				
A28520	RIVER CITY STONE INC	MANCHESTER		SW	10	TO88	R05W	2.65		X				
A28524	KUHLMAN CONST CO	LAKE DELHI		NW	14	TO88	R05W	2.64		X				

NOTE 1: FRICTION TYPE TO BE DETERMINED WHEN USED

RECENTLY ACTIVE AGGREGATE SOURCES

CODE	OPERATOR	SOURCE NAME	LOCATION					BULK SSD SpGr	DUR PCC CA	FA	FRICT HMA A	B	BEDS	NOTE
29	**DES MOINES DIST 5**	**CRUSHED STONE**												
A29002	L&W QUARRIES INC	MEDIAPOLIS-LEONARD		SE	01	TO71	R04W	2.65	3				15	1
											4	4	15 - 18	
											5	5	20	
A29008	CESSFORD CONST CO	NELSON		NE	26	TO72	R02W	2.62	3				21 - 24	
											4	4	7 - 20	
												4	15 - 24	
											5	5	24 - 27	
A29012	CESSFORD CONST CO	GEODE		NE	01	TO69	R05W				4	4	11 - 12	
											5	5	9 - 13	
											4	4	17	
		SAND & GRAVEL												
A29502	CESSFORD CONST CO	SPRING GROVE		SW	36	TO69	R03W	DWU	3		4	4		
								2.66		X				
30	**DICKINSON DIST 3**	**SAND & GRAVEL**												
A30502	CONCRETE SAND & MATERIALS	MILFORD			12	TO98	R37W	2.70	2		3	3		
								2.66		X				
A30504	ROHLIN CONST CO INC	ROHLIN		NE	06	TO98	R36W				3	3		
A30506	HUMMEL S&G	FOSTORIA		NE	26	TO98	R37W				4	4		
A30508	HALLETT MATERIALS CO	FOSTORIA/LOST			32	TO98	R37W	2.71	2		3	3		
								2.67		X				
30510	CEMSTONE S&G	EAST		NE	07	TO98	R36W	2.71	2		3	3		
								2.66		X				
A30512	DICKINSON CO	WESTPORT		NE	17	TO98	R38W				4	4		
A30514	HALLETT MATERIALS CO	MILFORD/LEITH		NE	04	TO98	R37W	DWU	2					
A30516	COHRS CONSTRUCTION INC	CROSBY		NW	21	T100	R37W							
A30518	COHRS CONSTRUCTION INC	SMITH		SE	06	TO98	R36W							
A30520	HALLETT MATERIALS CO	MILFORD/DERNER	W2 13	E2	14	TO98	R37W	DWU	2					
								DWU		X				
A30522	HALLETT MATERIALS CO	FODNESS		CT	23	T100	R36W							

NOTE 1: AASHTO 57 GRADATION MAXIMUM

RECENTLY ACTIVE AGGREGATE SOURCES

CODE	OPERATOR	SOURCE NAME	LOCATION				BULK SSD SpGr	DUR PCC CA	FA	FRICT HMA A	B	BEDS	T E
31	**DUBUQUE DIST 6**	**CRUSHED STONE**											
A31002	RIVER CITY STONE INC	ROSE SPUR		27	TO90	R02E	2.66	3i				1 - 8	
										4	4	1 - 15	
A31006	KUHLMAN CONST CO	DYERSVILLE-SUNDHEIM	SE	32	TO89	R02W	2.66	3i		4	4	4 - 12	
										4	4	1 - 8	
A31008	RIVER CITY STONE INC	KLEIN-RICHARDSVILLE	NW	33	TO90	R01E	DWU	3i				3A - 4B	
										4	4	1 - 4	
A31010	RIVER CITY STONE INC	BROWN	NW	33	TO89	R02E	2.68	3i		4	4	3 - 9A	
										4	4	2 - 9	
A31014	BARD CONCRETE CO	KURT	N2	35	TO87	R02W	2.70	3iB		4	4	1 - 2	
A31018	RIVER CITY STONE INC	MELOY	NW	23	TO87	R01E	DWU	3i		4	4	1 - 3	
A31020	RIVER CITY STONE INC	SCHLITCHE	SE	11	TO89	R02W	DWU	3i		4	4	1 - 4	
A31024	KUHLMAN CONST CO	JOHNS CREEK	SW	36	TO88	R02W	2.69	3i				3 - 4	
										4	4	1 - 4	
A31026	WENDLING QUARRIES INC	ARNSDORF	SE	25	TO87	R02E	DWU	3i		4	4	1 - 2	
A31028	RIVER CITY STONE INC	THOLE	NW	21	TO87	R02E	DWU	3i			4	1 - 2	1
A31030	RIVER CITY STONE INC	KEMP	NE	09	TO89	R01W					4		
A31034	RIVER CITY STONE INC	HERMSEN	NE	33	TO90	R02W					4		
A31036	RIVER CITY STONE INC	BALLTOWN	SE	05	TO90	R01E							
A31038	RIVER CITY STONE INC	HARTBECKE	SW	21	TO88	R01W					4		
A31040	RIVER CITY STONE INC	KENNEDY	NW	03	TO88	R01W					4		
A31042	RIVER CITY STONE INC	GANSEN	NW	09	TO87	R02E					4		
A31046	WENDLING QUARRIES INC	DECKER	SE	24	TO87	R02E	DWU	3i		4	4	1 - 5	
A31048	RIVER CITY STONE INC	MCDERMOTT	NE	35	TO88	R01W	2.65	3i		4	4	2	
A31050	RIVER CITY STONE INC	PLOESSEL-DYERSVILLE	N2	07	TO88	R02W	2.74	3i		4	4	3 - 5	
A31052	KUHLMAN CONST CO	EPWORTH-KIDDER	SW	02	TO88	R01W							
A31054	RIVER CITY STONE INC	MERRITT	SE	05	TO89	R02E							
A31056	RIVER CITY STONE INC	RUBIE	SE	06	TO88	R03E	DWU	3iB		4	4	5 - 9	2
A31058	RIVER CITY STONE INC	HOLY CROSS	SW	12	TO90	R02W							
A31060	BARD CONCRETE CO	EAST CASCADE	SE	22	TO87	R01W	2.71	3i		4	4	2 - 5	
A31064	RIVER CITY STONE INC	WEBER	NW	32	TO89	R02E	2.67	3i		4	4	3 - 9A	
A31066	RIVER CITY STONE INC	FILLMORE	SW	26	TO87	R01W	2.70	3i		4	4	2 - 4	
		SAND & GRAVEL											
A31502	AGGREGATE MATLS.-FLYNN	NINE MILE ISLAND	NE	24	TO88	R03E	2.66	3i		3	3		
							2.66		X				
A31504	BARD CONCRETE CO	SAUSER PROPERTY	NW	36	TO87	R02W				4	4		
							2.66		X				
A31512	BARD CONCRETE CO	BURKLE	SW	19	TO89	R02W	2.66		X				
A31514	RIVER CITY STONE INC	FILLMORE	CT	26	TO87	R01W	2.66		X				

NOTE 1: TOP 17.0' OF BED 2
NOTE 2: TOP 6.0' OF BED 9

RECENTLY ACTIVE AGGREGATE SOURCES

CODE	OPERATOR	SOURCE NAME	LOCATION				BULK SSD SpGr	DUR PCC CA	FA	FRICT HMA A	B	BEDS	NOTE
32	**EMMET DIST 3**	**SAND & GRAVEL**											
A32502	HALLETT MATERIALS CO	ESTHERVILLE	N2	03	TO99	R34W	2.70	2		3	3		
							DWU		X				
A32506	EMMET COUNTY	FREY	NW	21	T100	R34W				4	4		
A32514	BOGGESS CONST	WALLINGFORD		07	TO98	R33W					4		
							DWU		X				
A32518	ROHLIN CONST CO INC	EGELAND		20	TO98	R33W				4	4		
A32520	ROHLIN CONST CO INC	YOUNG	NE	19	TO98	R32W				4	4		
A32522	ESTHERVILLE ROCK & GRAVEL	OLD ESTHERVILLE S&G		30	TO99	R33W							
A32524	EMMET COUNTY	PETERSON	SW	34	T100	R34W							
A32526	ROHLIN CONST CO INC	DAVID YOUNG	NE	29	TO98	R33W				4	4		
A32530	HALLETT MATERIALS CO	ESTHERVILLE/WHITE	SW	16	T100	R34W	DWU	2		4	4		
							DWU		X				
A32534	ROHLIN CONST CO INC	ENERSON		28	T100	R34W				4	4		
A32538	ESTHERVILLE ROCK & GRAVEL	JENSEN	NW	03	T099	R34W	DWU	2					
							DWU		X				
A32540	HALLETT MATERIALS CO	FISHER	NE	33	TO98	R32W							
A32542	HALLETT MATERIALS CO	GRAETTINGER	SE	33	TO98	R33W				4	4		
A32544	DUININCK BROS INC	ANDERSON		7,8	T100	R34W							
33	**FAYETTE DIST 2**	**CRUSHED STONE**											
A33002	NIEMANN CONST CO	ELDORADO-JACOBSEN	SW	17	TO95	R08W	2.69	3iB		5	5	4 - 6B	
A33004	NIEMANN CONST CO	HOUG	SW	11	TO94	R08W				5	5	1 - 9	
A33006	NIEMANN CONST CO	MARYVILLE	SE	24	TO91	R07W	2.69	3i		4	4	1 - 2	
33010	WILTGEN CONST CO	VOSHELL	NW	21	TO93	R07W				X	X	1 - 4	
33016	NIEMANN CONST CO	MAYNARD	NE	23	TO92	R09W					X		
A33018	NIEMANN CONST CO	FAIRBANK	SW	28	TO91	R10W		X		4	4	5	
											4	1 - 5	
A33020	NIEMANN CONST CO	YEAROUS	SW	19	TO93	R08W				4	4	1 - 10	
A33022	NIEMANN CONST CO	MILLER	SW	35	TO95	R10W				4	4	1 - 8	
A33024	NIEMANN CONST CO	WAUCOMA	NW	25	TO95	R10W	2.69	3iB		5	5	2 - 4	
A33026	WILTGEN CONST CO	LYNCH	NW	05	TO95	R10W				4	4	1 - 5	
A33030	NIEMANN CONST CO	SCHWEMMAN-ST LUCAS	NE	29	TO95	R09W				X	X		
A33032	BRUENING ROCK PROD INC	LANDIS	SE	12	TO93	R08W		X		4	4	1 - 5	
A33034	NIEMANN CONST CO	MCDONOUGH	SE	36	TO94	R08W							
A33036	NIEMANN CONST CO	GRAHAM-HAWKEYE	SW	06	TO94	R09W		X		4	4	1 - 4	
A33038	NIEMANN CONST CO	PAPE	NE	28	TO95	R08W	DWU	3iB		5	5	3 - 5	
A33040	NIEMANN CONST CO	SINNOTT		25	TO93	R09W							
		SAND & GRAVEL											
A33506	NIEMANN CONST CO	ALPHA	NW	03	TO94	R10W	2.64	X		4	4		
							2.64		X				
A33508	CARLSON MATERIALS CO	DURSCHER	NW	03	TO94	R07W					4		
A33510	ZUPKE S&G	RANDALIA	NW	29	TO93	R09W				4	4		
							2.66		X				
A33512	NIEMANN CONST CO	WADENA	NE	25	TO93	R07W				4	4		
							2.66		X				
A33518	KUHLMAN CONST CO	BASSETT	SE	11	TO91	R07W				4	4		
							2.65		X				
A33520	BRUENING ROCK PROD INC	OELWEIN SAND	NE	09	TO91	R09W	2.65		X				
A33522	BRUENING ROCK PROD INC	PAPE	SE	08	TO95	R08W	2.65		X				
A33524	CROELL REDI-MIX	ROGERS		04	TO94	R07W	2.66		X				
A33526	WILTGEN CONST CO	ELDORADO	NE	13	TO95	R09W							
A33528	NIEMANN CONST CO	KASEMEIER	SE	19	TO93	R10W	DWU		X				

RECENTLY ACTIVE AGGREGATE SOURCES

CODE	OPERATOR	SOURCE NAME	LOCATION				BULK SSD SpGr	DUR PCC CA	FA	FRICT HMA A	B	BEDS	T E
34	**FLOYD DIST 2**	**CRUSHED STONE**											
A34002	GREENE LS CO	CARVILLE-BUNN	SW	23	TO95	R15W	2.63	2		4	4	1 - 4	
A34004	GREENE LS CO	MAXON	SE	07	TO94	R17W	2.68	2				4C - 19	
										5	5	1 - 17	
A34006	GREENE LS CO	JOHLAS	SW	07	TO94	R15W					X		
A34008	GREENE LS CO	WARNHOLTZ	SW	09	TO96	R16W	2.70	3i		5	5	1 - 4	
							2.68	2		4	4	17 - 18	
											X	1 - 18	
A34010	GREENE LS CO	LACOSTA	SE	25	TO97	R17W	2.67	3i		5	5	1 - 4	
										5	5	1 - 8	
										4	4	9 - 14	
A34012	GREENE LS CO	WILLIAMS	NW	29	TO96	R18W							
A34014	BRUENING ROCK PROD INC	HANNMANN	NE	20	TO94	R15W							
A34018	CROELL REDI-MIX	JONES	N	26	TO97	R17W							
		SAND & GRAVEL											
A34502	GREENE LS CO	ROCKFORD	SE	15	TO95	R18W	2.68	2		3	3		
							2.65		X				
A34506	GREENE LS CO	LENT	NE	08	TO96	R16W				4	4		
A34510	GREENE LS CO	BRACKEL	NE	17	TO94	R17W				4	4		
A34514	GREENE LS CO	LITTLE CEDAR	NW	01	TO95	R15W	2.65		X	3	3		
A34516	GREENE LS CO	CEDAR ACRE RESORTS	E2	17	TO95	R15W	2.65		X				
A34518	GREENE LS CO	ENABNIT	NW	21	TO94	R17W							
35	**FRANKLIN DIST 2**	**CRUSHED STONE**											
A35002	MARTIN MARIETTA	DOWS	NE	30	TO91	R22W				4	4	1 - 4	
										4	4	1 - 12	
										4	4	7 - 12	
										5	5	5 - 6	
A35006	MARTIN MARIETTA	HIBNESS	SE	22	TO91	R20W	2.58	3				1 - 4A	
										4	4	1 - 12	
A35010	GREENE LS CO	MILLER	NE	13	TO91	R19W					4	1 - 5	
A35016	GREENE LS CO	AYRES		01	TO92	R19W							
		SAND & GRAVEL											
A35502	CARLSON MATERIALS CO	GENEVA	SW	07	TO91	R19W	2.68	2		3	3		
							2.64		X				
A35508	MARTIN MARIETTA	STUCK	SW	30	TO91	R22W				4	4		
A35512	MARTIN MARIETTA	ANDERSON-POPEJOY	NE	28	TO90	R22W	2.68		X	3	3		
A35514	CARLSON MATERIALS CO	KOCH	SW	08	TO91	R19W				4	4		
							2.69		X				
A35516	KNIFE RIVER	PETERS	SW	04	TO92	R20W				3	3		
							2.65		X				
A35518	KNIFE RIVER	REINKE	SW	22	TO91	R20W				4	4		
A35520	KNIFE RIVER	BRANDT	N2	34	TO90	R19W				4	4		
							2.68		X				
A35522	MARTIN MARIETTA	RASH	SE	27	TO90	R22W				4	4		
							2.63		X				
36	**FREMONT DIST 4**	**CRUSHED STONE**											
A36002	SCHILDBERG CONST CO INC	THURMAN	NW	23	TO70	R43W					4		
37	**GREENE DIST 1**	**SAND & GRAVEL**											
A37504	HALLETT MATERIALS CO	JEFFERSON	SW	04	TO83	R31W	2.66	2		4	4		
							2.64		X				
A37514	ARCADIA LIMESTONE CO	WRIGHT	NW	05	TO84	R32W				4	4		
							2.66		X				
A37520	GREENE CO REDI MIX	HAMILTON		27	TO83	R30W	2.59		X				
A37522	KNIFE RIVER	HAUPERT		20	TO84	R30W							

RECENTLY ACTIVE AGGREGATE SOURCES

CODE	OPERATOR	SOURCE NAME	LOCATION					BULK SSD SpGr	DUR PCC CA	FA	FRICT HMA A	B	BEDS	NOTE
38	**GRUNDY DIST 1**	**SAND & GRAVEL**												
A38504	CARLSON MATERIALS CO	HERONIMOUS		SE	35	TO88	R17W	2.63		X				
A38506	CARLSON MATERIALS CO	MEESTER	NE	NE	12	TO88	R17W	2.63		X				
39	**GUTHRIE DIST 4**	**SAND & GRAVEL**												
A39502	KNIFE RIVER	HEILAND		SW	29	TO79	R30W				4	4		
A39506	BUTTLER CONST CO	BAYARD		NE	22	TO81	R32W				4	4		
A39508	MCALISTER AGGREGATES LLC	L & L		NE	33	TO78	R31W				4	4		
40	**HAMILTON DIST 1**	**CRUSHED STONE**												
A40006	MARTIN MARIETTA	GRANDGEORGE		SE	18	TO89	R25W					5	3 - 5	
		SAND & GRAVEL												
A40512	KNIFE RIVER	ANDERSON			12	TO87	R26W							
41	**HANCOCK DIST 2**	**CRUSHED STONE**												
A41002	BMC AGGREGATES LC	GARNER NORTH		SE	11	TO95	R24W	2.77	3iB		4	4	1 - 4	
								2.77	3i		4	4	6	
A41004	BMC AGGREGATES LC	GARNER SOUTH-WIELAND		NW	13	TO95	R24W	2.77	3iB		4	4	1 - 4	
								2.77	3i		4	4	6	
		SAND & GRAVEL												
A41504	HANCOCK COUNTY	HUTCHINS		E2	27	TO96	R26W					4		
A41506	HANCOCK COUNTY	KLEMME			26	TO95	R24W					4		
A41510	NUCKOLL'S CONCRETE	BRITT			34	TO96	R26W	DWU	2		3	3		
	SERVICES INC							DWU		X				
A41518	HANCOCK COUNTY	AUSTIN		NE	11	TO97	R25W							
2	**HARDIN DIST 1**	**CRUSHED STONE**												
A42002	MARTIN MARIETTA	ALDEN		NW	20	TO89	R21W	2.59	3iB		4	4	0 - 3	1
								DWU	3iB				3	
								DWU	3				0 - 1	
A42004	GERHKE QUARRIES INC	GIFFORD		NW	04	TO86	R19W					5		
		SAND & GRAVEL												
A42502	WELDON BROS CONST CO	IOWA FALLS		NW	20	TO89	R20W	2.65	2		4	4		
								2.68		X				
A42510	MARTIN MARIETTA	JANSSEN		SE	34	TO89	R20W	2.65			4	4		
								2.65		X				
A42512	HARDIN AGGREGATES INC	GIFFORD		SW	31	TO87	R19W				4	4		
								2.66		X				
A42524	KNIFE RIVER	GRIFFEL		SE	31	TO89	R19W				3	3		
A42528	KNIFE RIVER	LLOYD			04	TO86	R19W	DWU			4	4		

NOTE 1: WHEN BED 2 IS VISUALLY APPARENT, IT SHALL NOT EXCEED A THICKNESS OF ONE FOOT IN FULL-FACE OPERATION.

RECENTLY ACTIVE AGGREGATE SOURCES

CODE	OPERATOR	SOURCE NAME	LOCATION				BULK SSD SpGr	DUR PCC CA	FA	FRICT HMA A	B	BEDS	T E
43	**HARRISON DIST 4**	**CRUSHED STONE**											
A43002	SCHILDBERG CONST CO INC	LOGAN		19	TO79	R42W				5	5	25E	
										5	5	25C- 25E	
											4	26	
A43004	NATURAL MATERIALS	LOGAN		17	TO79	R42W				5	5	25E	
										5	5	25C- 25E	
											4	26	
		SAND & GRAVEL											
A43506	SCHEMMER LS INC	LOGAN	SE	08	TO79	R42W				3	3		
							DWU		X				
A43512	HALLETT MATERIALS CO	WOODBINE-MCCANN	SW	29	TO81	R41W	2.68	3		3	3		
							2.64		X				
A43514	NATURAL MATERIALS	LOGAN		17	TO79	R42W							
44	**HENRY DIST 5**	**CRUSHED STONE**											
A44002	COOTS MATERIALS CO INC	SMITH	SE	17	TO71	R06W							
A44006	HENRY COUNTY	LEEPER	NE	18	TO71	R06W	DWU	2		4	4	8 - 11	
A44008	DOUDS STONE INC	TWEEDY	SW	36	TO71	R06W				4	4	13 - 14	
										5	5	9 - 14	
		SAND & GRAVEL											
A44502	CESSFORD CONST CO	NORTH ROME	SW	29	TO72	R07W				4	4		
							2.66		X				
A44504	IDEAL SAND CO	ENSMINGER-ROME	NW	32	TO72	R07W	2.67		X				
45	**HOWARD DIST 2**	**CRUSHED STONE**											
A45002	ROVERUD CONST INC	ECKERMAN	NW	33	T100	R11W	2.61	2		X	X	8 - 9	
A45006	BRUENING ROCK PROD INC	NELSON	NE	33	TO99	R13W	2.54	2		4	4	1 - 3	
							2.54	2		4	4	8 - 9	
A45008	BRUENING ROCK PROD INC	DOTZLER	NE	23	TO99	R12W	2.50	3		4	4	7 - 10A	
A45010	BRUENING ROCK PROD INC	DALEY	NE	11	TO98	R11W	2.59	3		4	4	9 - 11	
A45014	FALK CONST CO	CECELIA	SE	08	TO97	R14W					5		
A45018	BRUENING ROCK PROD INC	LE ROY	NW	10	T100	R14W					X		
A45020	BRUENING ROCK PROD INC	RIECKS	NW	24	T100	R11W							
A45022	BRUENING ROCK PROD INC	MAUER	SE	13	T100	R13W							
A45024	BRUENING ROCK PROD INC	MAPLE LEAF	SE	04	TO98	R13W							
A45026	BRUENING ROCK PROD INC	BRUENING BROTHERS #1	SE	22	T100	R11W						1 - 3	
A45028	BRUENING ROCK PROD INC	ELMA	NW	06	TO97	R13W	DWU	3		4	4	2 - 3B	
A45030	BRUENING ROCK PROD INC	DIEKEN-TANK	SE	24	T100	R13W							
A45032	ROVERUD CONST INC	KITCHEN		13	T100	R12W							
		SAND & GRAVEL											
A45502	BRUENING ROCK PROD INC	MAPLE LEAF-POTTER	SE	04	TO98	R13W				4	4		
A45504	ROVERUD CONST INC	ECKERMAN	NW	33	T100	R11W	DWU	3		4	4		
							2.65		X				
A45508	CARLSON MATERIALS CO	SOVEREIGN	SW	01	TO98	R12W	DWU	3		3	3		
							2.65		X				
A45514	CARLSON MATERIALS CO	EASTLAND	NE	26	T100	R14W				3	3		
A45516	CARLSON MATERIALS CO	FREIDERICH	NE	15	TO98	R14W				3	3		
							2.67		X				
A45518	BRUENING ROCK PROD INC	ELMA	NW	06	TO97	R13W	2.67		X				

RECENTLY ACTIVE AGGREGATE SOURCES

CODE	OPERATOR	SOURCE NAME	LOCATION				BULK SSD SpGr	DUR PCC		FRICT HMA		BEDS	NOTE
								CA	FA	A	B		
46	**HUMBOLDT DIST 2**	**CRUSHED STONE**											
A46006	MARTIN MARIETTA	HODGES	NE	32	TO92	R28W	2.60	3i		4	4	10 - 18	
							DWU	3i		5	5	4 - 8	
A46014	MARTIN MARIETTA	PEDERSEN	SW	28	TO92	R28W	2.59	3i		5	5	4 - 13	
							2.58	3i		5	5	4 - 20	
							2.57	3i		5	5	14 - 20	
A46016	KNIFE RIVER	ERICKSON		30	TO91	R28W							
		SAND & GRAVEL											
A46504	MARTIN MARIETTA	PETERSON	SW	27	TO92	R29W				4	4		
A46512	NORTHWEST MATERIALS	WARREN	SW	08	TO92	R30W	DWU			X	X		
A46516	KNIFE RIVER	ERICKSON		30	TO91	R28W				3	3		
A46518	MARTIN MARIETTA	PEDERSEN	SW	28	TO92	R28W			X				
47	**IDA DIST 3**	**SAND & GRAVEL**											
A47502	HALLETT MATERIALS CO	BATTLE CREEK		05	TO86	R41W				3	3		
A47504	HIGMAN SAND & GRAVEL	CROCKER	NW	06	TO89	R41W							
48	**IOWA DIST 6**	**SAND & GRAVEL**											
A48502	MARENGO READY MIX	KIMMICH	SE	24	TO81	R11W				4	4		
							2.66		X				
A48506	WENDLING QUARRIES INC	MARENGO	NW	22	TO81	R11W	2.66		X				
A48508	MARENGO READY MIX	DISTERHOFF	SE	34	TO81	R10W	2.66		X				

RECENTLY ACTIVE AGGREGATE SOURCES

CODE	OPERATOR	SOURCE NAME	LOCATION				BULK SSD SpGr	DUR PCC CA	FA	FRICT HMA A	B	BEDS	TE
49	**JACKSON DIST 6**	**CRUSHED STONE**											
A49002	BELLEVUE S&G CO	BELLEVUE	SW	25	TO87	R04E	2.67	3i		4	4	1 - 3	
A49004	BELLEVUE S&G CO	LAMOTT	NW	02	TO86	R03E				4	4		
A49008	WENDLING QUARRIES INC	IRON HILL	SW	16	TO85	R02E	DWU	3i		4	4	3 - 6	
										4	4	1 - 6	
A49010	WENDLING QUARRIES INC	ANDREW	NW	21	TO85	R03E	2.70	3iB		4	4	1B - 3	
										4	4	1 - 7	
A49012	WENDLING QUARRIES INC	FROST	SE	16	TO84	R03E	DWU	3iB		4	4	1A - 1D	
										4	4	1 - 2	
A49016	WENDLING QUARRIES INC	WEIS	SE	22	TO85	R04E					4		
A49018	WENDLING QUARRIES INC	PATASKA	NW	23	TO85	R05E					4		
A49020	WENDLING QUARRIES INC	PRESTON	SW	26	TO84	R05E	2.67	3i		4	4	7 - 10	
										4	4	1 - 10	
A49021	PRESTON READY MIX	PRESTON R/M	SW	26	TO84	R05E	2.67	3i		4	4	7 - 10	
										4	4	1 - 10	
A49022	WENDLING QUARRIES INC	BELLEVUE	SE	23	TO86	R04E				4	4		
A49024	WENDLING QUARRIES INC	MAQUOKETA EAST	SW	07	TO84	R03E	DWU	3i				1 - 8	
							2.70	3i		4	4	7 - 8	
A49026	WENDLING QUARRIES INC	MILES	SW	20	TO84	R06E					4		
A49028	WENDLING QUARRIES INC	FULTON	SW	25	TO85	R02E	DWU	3i		4	4	2	
										4	4	1 - 2	
A49030	BELLEVUE S&G CO	SPRINGBROOK		15	TO85	R04E				4	4		
A49032	WENDLING QUARRIES INC	OTTER CREEK-GLAHN	CT	21	TO86	R02E							
A49034	WENDLING QUARRIES INC	KILBURG	NW	21	TO85	R05E							
A49040	WENDLING QUARRIES INC	JOINERVILLE-HAMANN	SE	20	TO84	R02E				4	4	1 - 3	
A49042	WENDLING QUARRIES INC	PETERSON		24	TO84	R06E				4	4	1 - 2	
A49044	WENDLING QUARRIES INC	FRANK	NW	14	TO87	R04E							
A49046	WENDLING QUARRIES INC	ROWAN	NE	25	TO86	R03E							
A49048	PRESTON READY MIX	DRURY	CT	32	TO85	R06E							
A49050	RIVER CITY STONE INC	MARSHALL	NW	01	TO84	R06E							
A49052	WENDLING QUARRIES INC	STILLMUNKES		10	TO85	R05E							
A49054	DUANE KUNDE	KUNDE	E2	33	TO84	R05E							
A49058	WENDLING QUARRIES INC	61 ROAD CUT	N2	31	TO84	R03E	2.67	3i		4	4	1	
A49060	BELLEVUE S&G CO	ST DONATUS		18	TO87	R04E							
A49062	PRESTON READY MIX	JOHNSON		31	TO84	R04E							
A49064	BELLEVUE S&G CO	VEACH		01	TO85	R02E							
A49066	BELLEVUE S&G CO	MOREHEAD	NW	13	TO85	R01E							
		SAND & GRAVEL											
A49504	WENDLING QUARRIES INC	KNIPELMEYER	NE	36	TO87	R04E				4	4		
							2.64		X				
A49506	BELLEVUE S&G CO	BELLEVUE	E2	01	TO86	R04E	2.64	3iB		3	3		
							2.68		X				
A49510	WENDLING QUARRIES INC	MAQUOKETA	NE	13	TO84	R02E				4	4		
							2.65		X				
A49516	WENDLING QUARRIES INC	TURNER	NE	07	TO84	R07E	2.63	3iB		3	3		
							2.65		X				
A49520	WENDLING QUARRIES INC	BALDWIN	SW	28	TO84	R01E	2.66		X				
A49522	CENTURY READY MIX	EWING	NW	02	TO84	R01E	DWU		X				
A49524	BELLEVUE S&G CO	GRIEBEL	SE	25	TO87	R04E	DWU	3B		4	4		
							2.67		X				
A49526	BELLEVUE S&G CO	BELLEVUE FARM	SE	25	TO87	R04E	DWU	3i					
							DWU		X				
A49528	AGGREGATE MATERIALS CO	STEVENS	NW	02	TO84	R01E	2.65		X				
A49530	PRESTON READY MIX	PETERSEN	SW	18	TO84	R07E	DWU	3iB		4	4		
							DWU		X				
A49532	WEBER STONE CO INC	IRON HILL	NE	16	TO85	R02E	2.65		X				
A49534	PRESTON READY MIX	MARBURGER	SE	13	TO84	R07E	DWU		X				

RECENTLY ACTIVE AGGREGATE SOURCES

CODE	OPERATOR	SOURCE NAME	LOCATION				BULK SSD SpGr	DUR PCC CA	FA	FRICT HMA A	B	BEDS	NOTE
50	**JASPER DIST 1**	**CRUSHED STONE**											
A50002	MARTIN MARIETTA	SULLY MINE	SE	16	TO79	R17W	2.54	3i		4	4	36 - 41	
											4	10 - 19	
		SAND & GRAVEL											
A50502	MARTIN MARIETTA	COLFAX	NE	01	TO79	R21W	2.66	2		3	3		
							2.67		X				
A50504	MARTIN MARIETTA	REASNOR	NE	10	TO78	R19W				4	4		
							2.66		X				
51	**JEFFERSON DIST 5**	**CRUSHED STONE**											
A51006	WINN CORP	JEFFERSON	NE	09	TO71	R10W							
52	**JOHNSON DIST 6**	**CRUSHED STONE**											
A52002	WENDLING QUARRIES INC	FOUR CO	NW	04	TO81	R08W					X		
A52004	RIVER PRODUCTS CO	CONKLIN	NW	33	TO80	R06W	2.66	3iB		4	4	2 - 10	
							DWU	3i		5	5	23 - 24	1
										5	5	2 - 5	
										4	4	6 - 10	
										4	4	21	
A52006	RIVER PRODUCTS CO	KLEIN	NW	02	TO79	R07W	2.66	3iB		4	4	2 - 10	
							DWU	3i		5	5	23 - 24	1
										5	5	2 - 5	
										4	4	6 - 10	
										4	4	21	
A52008	RIVER PRODUCTS CO	ERNST	SW	20	TO80	R05W					X		
		SAND & GRAVEL											
52502	S&G MATERIALS INC	SHOWERS	NE	27	TO79	R06W				4	4		
							2.65		X				
A52506	S&G MATERIALS INC	BUTLER	SW	33	TO79	R06W	DWU		X				
A52508	S&G MATERIALS INC	WILLIAMS	NW	34	TO79	R06W	DWU		X				

NOTE 1: 1.25 INCH MAXIMUM TOP SIZE

RECENTLY ACTIVE AGGREGATE SOURCES

CODE	OPERATOR	SOURCE NAME	LOCATION				BULK SSD SpGr	DUR PCC CA	FA	FRICT HMA A	B	BEDS	T E
53	**JONES DIST 6**	**CRUSHED STONE**											
A53002	BARD CONCRETE CO	FARMERS-BEHRENDS	NE	14	TO86	R03W	2.64	3i		4	4	1 - 5	
A53004	WENDLING QUARRIES INC	MONTICELLO	NE	24	TO86	R04W	2.66	3i		4	4	1	
A53006	WENDLING QUARRIES INC	ANAMOSA	SE	13	TO84	R04W	DWU	3i				1 - 5	
										4	4	1 - 6	
A53010	WENDLING QUARRIES INC	BALLOU-OLIN	NE	24	TO83	R03W	DWU	3iB				3	
							DWU	3				2 - 3	
										4	4	1 - 3	
A53012	WENDLING QUARRIES INC	WYOMING		33	TO84	R01W	2.69	3iB		4	4	1 - 2C	
A53014	WEBER STONE CO INC	JACOBS-SCOTCH GROVE	SW	07	TO85	R02W					5		
A53016	WEBER STONE CO INC	STONE CITY		5,6	TO84	R04W	2.45	3i		4	4	2B - 3	
A53018	RIVER CITY STONE INC	FINN	NE	06	TO85	R01W	DWU	3i		4	4	2 - 5	
A53020	WENDLING QUARRIES INC	CANTON	NE	24	TO85	R01W					X		
A53024	RIVER CITY STONE INC	SULLIVAN	NW	14	TO86	R03W	DWU	3i				1 - 5	
A53026	RIVER CITY STONE INC	ANAMOSA	SW	15	TO84	R04W							
		SAND & GRAVEL											
A53502	WENDLING QUARRIES INC	MONTICELLO	SE	07	TO86	R03W				4	4		
							2.66		X				
A53506	RIVER CITY STONE INC	FINN	N2	06	TO85	R01W				4	4		
							2.65		X				
A53508	WENDLING QUARRIES INC	ANAMOSA-VERNON	SW	13	TO84	R04W				4	4		
							2.66		X				
A53510	WENDLING QUARRIES INC	KNAPP	SE	27	TO84	R03W				4	4		
							2.65		X				
A53514	WENDLING QUARRIES INC	FLEMING	NE	12	TO83	R03W				4	4		
							2.66		X				
A53522	WEBER STONE CO INC	WEBER	SE SW	05	TO84	R04W	2.66		X				
A53526	BARD CONCRETE CO	STEPHENS	NW	34	TO86	R03W				4	4		
							2.66		X				
A53528	WEBER STONE CO INC	ANAMOSA	NE	14	TO84	R04W	2.65		X				
A53530	RIVER CITY STONE INC	ANAMOSA-WOOD'S	CT	15	TO84	R04W	2.66		X				
54	**KEOKUK DIST 5**	**CRUSHED STONE**											
A54002	DOUDS STONE INC	KESWICK	NW	21	TO77	R12W	2.61	2		4	4	13 - 15	1
										4	4	13 - 18	
A54004	DOUDS STONE INC	OLLIE	SW	01	TO74	R11W	2.66	3		4	4	13 - 18	
							2.57	3				27 - 29	1
										4	4	13 - 19	
										4	4	27 - 30	
											5	31 - 33	
A54008	DOUDS STONE INC	HARPER	SE	11	TO76	R11W				4	4	15 - 24	
										4	4	32 - 37	
										4	4	38 - 40	
A54010	DOUDS STONE INC	LYLE	NW	13	TO74	R13W	DWU	3				40	
										4	4	36 - 38	
		SAND & GRAVEL											
A54502	WINN S&G	WINN	SE	06	TO74	R10W	2.66		X				

NOTE 1: 1.25 INCH MAXIMUM TOP SIZE

RECENTLY ACTIVE AGGREGATE SOURCES

CODE	OPERATOR	SOURCE NAME	LOCATION				BULK SSD SpGr	DUR PCC CA	FA	FRICT HMA A	B	BEDS	NOTE
55	**KOSSUTH DIST 2**	**SAND & GRAVEL**											
A55506	KOSSUTH COUNTY	WHITTEMORE	NW	16	TO95	R30W				4	4		
A55508	KOSSUTH COUNTY	IRVINGTON	NW	36	TO95	R29W				4	4		
A55518	REDING S&G	REDING		02	TO94	R29W							
A55536	HANSEN CONST CO	BREESE	NE	15	TO98	R30W							
A55548	MARTIN MARIETTA	BORMANN SAND	NW	39	TO94	R29W							
56	**LEE DIST 5**	**CRUSHED STONE**											
A56002	CESSFORD CONST CO	HAWKEYE	NE	10	TO68	R06W					5	1 - 21	
										4	4	22 - 27	
A56004	CESSFORD CONST CO	FRANKLIN	NE	25	TO68	R06W	2.49	2				12	1
										4	4	12 - 14	
A56006	CESSFORD CONST CO	ARGYLE	SE	18	TO66	R06W				4	4	1 - 17	
											5	4 - 12	
										4	4	13 - 17	
A56008	CESSFORD CONST CO	DONNELLSON	SE	05	TO67	R06W				4	4	10 - 15	
A56012	CESSFORD CONST CO	VINCENNES	NW	19	TO66	R06W							
		SAND & GRAVEL											
A56504	CESSFORD CONST CO	VINCENNES	SE	32	TO66	R06W				4	4		
							2.67		X				
A56506	BROCKMAN SAND CO	FORT MADISON	SW	11	TO67	R05W				4	4		
							2.67		X				
A56508	SHIPLEY CONTRACTING CORP	LEE COUNTY S&G	SE	11	TO67	R05W	DWU		X				

NOTE 1: AASHTO 57 GRADATION MAXIMUM

RECENTLY ACTIVE AGGREGATE SOURCES

CODE	OPERATOR	SOURCE NAME	LOCATION				BULK SSD SpGr	DUR PCC CA	FA	FRICT HMA A	B	BEDS	T E
57	**LINN DIST 6**	**CRUSHED STONE**											
A57002	WENDLING QUARRIES INC	BETENBENDER-COGGON	SW	03	TO86	R06W	DWU	3i				8 - 9	
							DWU	2				8 - 10	
A57004	WENDLING QUARRIES INC	PLOWER	SE	36	TO86	R06W	2.62	3				9 - 11	
										4	4	1 - 10	
A57006	WENDLING QUARRIES INC	ROBINS	NE	21	TO84	R07W	2.57	3i		4	4	3	1
A57008	WENDLING QUARRIES INC	BOWSER-SPRINGVILLE	SW	29	TO84	R05W	DWU	3i		4	4	6 - 7	
							DWU	3		4	4	8	
A57010	WENDLING QUARRIES INC	TROY MILLS	SE	09	TO86	R07W				X	X		
A57012	WENDLING QUARRIES INC	MORGAN CREEK	SE	22	TO83	R08W				X	X		
A57014	WENDLING QUARRIES INC	SWEETING	NW	18	TO85	R08W					4		
A57016	WENDLING QUARRIES INC	ALICE	NW	08	TO85	R07W					4		
A57018	MARTIN MARIETTA	CEDAR RAPIDS	NE	15	TO82	R06W	2.64	3i				2 - 9	1
										4	4	2 - 14	
A57020	WENDLING QUARRIES INC	LISBON	NW	24	TO82	R05W	DWU	3iB		4	4	1	
A57022	CRAWFORD QUARRY CO	LEE CRAWFORD	NW	23	TO83	R08W	2.55	3i		4	4	8	
A57026	NIEMANN CONST CO	COOK	NW	10	TO86	R07W							
A57028	WENDLING QUARRIES INC	BEVERLY	NW	07	TO82	R07W	DWU	3i		4	4	6 - 7	
A57030	BRUENING ROCK PROD INC	HENNESSEY	NE	01	TO82	R07W	DWU	3i		4	4	4 - 5	
		SAND & GRAVEL											
A57502	WENDLING QUARRIES INC	SWEETING	NE	18	TO85	R08W				4	4		
							2.64		X				
A57506	WENDLING QUARRIES INC	CEDAR RAPIDS	NE	27	TO84	R08W				4	4		
							2.65		X				
A57508	WENDLING QUARRIES INC	EAST MARION	NE	36	TO84	R06W				3	3		
							2.65		X				
A57516	MARTIN MARIETTA	CEDAR RAPIDS SAND	SW	35	TO83	R07W	2.65		X				
A57520	WENDLING QUARRIES INC	IVANHOE	NW	29	TO82	R05W				4	4		
							2.66		X				
A57522	WENDLING QUARRIES INC	CENTRAL CITY	NE	10	TO85	R06W				4	4		
							2.65		X				
A57524	WENDLING QUARRIES INC	COGGON	NW	11	TO86	R06W				4	4		
							2.65		X				
A57526	WENDLING QUARRIES INC	TROY MILLS	SE	09	TO86	R07W	2.65		X				
A57528	AGGREGATES INC	AGGREGATES INC	SW	26	TO84	R08W	DWU	2B		3	3		
							2.65		X				
A57530	WENDLING QUARRIES INC	HESS	SW	04	TO82	R06W	DWU		X				
A57532	CROELL READY MIX	PALO	NE	21	TO84	R08W	DWU		X				
A57534	MARTIN MARIETTA	LINN COUNTY SAND	NE	05	TO82	R06W	DWU		X				
58	**LOUISA DIST 5**	**CRUSHED STONE**											
A58002	RIVER PRODUCTS CO	COLUMBUS JUNCTION	NW	03	TO74	R05W	2.55	3				16 - 19	2
										4	4	15 - 19	
										4	4	19 - 21	
		SAND & GRAVEL											
A58504	RIVER PRODUCTS CO	FREDONIA A INLAND	SW	17	TO75	R04W				4	4		
		PUMPING					2.66		X				
		FREDONIA B RIVER	SW	17	TO75	R04W				4	4		
		PUMPING					2.66		X				

NOTE 1: 1.25 INCH MAXIMUM TOP SIZE
NOTE 2: AASHTO 57 GRADATION MAXIMUM

RECENTLY ACTIVE AGGREGATE SOURCES

CODE	OPERATOR	SOURCE NAME	LOCATION				BULK SSD SpGr	DUR PCC CA	FA	FRICT HMA A	B	BEDS	NOTE
60	**LYON DIST 3**	**SAND & GRAVEL**											
A60502	PETTENGILL CONC & GRAVEL	ROCK RAPIDS #1	NW	33	T100	R45W	2.69	2		3	3		
							2.67		X				
A60504	PETTENGILL CONC & GRAVEL	ROCK RAPIDS #2	NE	09	T099	R45W				3	3		
A60506	PETTENGILL CONC & GRAVEL	ROCK VALLEY		17	T100	R45W				4	4		
A60508	DIETER PIT	DIETER	SE	24	T100	R49W				4	4		
A60510	HALLETT MATERIALS CO	OLSON	NW	21	T099	R48W				4	4		
A60512	JOE'S READY MIX INC	LITTLE ROCK	NW	03	T099	R43W	DWU	2		4	4		
							2.66		X				
A60514	MARTIN MARIETTA	DOON		21	T098	R45W				3	3		
A60516	MARTIN MARIETTA	OPEN	SW	24	T098	R46W				3	3		
A60518	ROCK VALLEY GRAVEL CO	OPEN	NW	17	T099	R48W				4	4		
A60520	HOGAN	WINTER	SE	18	T099	R43W				4	4		
A60522	HYMANS CONST CO	OPEN		17	T098	R44W				4	4		
A60524	MARTIN MARIETTA	OPEN		29	T098	R45W				4	4		
A60528	HYMANS CONST CO	RUDD		20	T100	R45W				4	4		
A60534	DUININCK BROS	EGEBO		16	T099	R48W				4	4		
A60536	ROHLIN CONST CO	VAN ENGEN	SW	35	T098	R46W							
A60540	SOUTHERN MN CONST CO INC	KANANGEITER	SE	04	T099	R43W							
A60542	KRUSE PAVING	EBEN	NW	17	T099	R43W							
A60544	DAKOTA ROAD BUILDERS INC	ORVE	NE	24	T100	R49W							
A60546	ROHLIN CONST CO	VANDERBRINK	NW	07	T098	R45W							
61	**MADISON DIST 4**	**CRUSHED STONE**											
A61002	SCHILDBERG CONST CO INC	EARLY CHAPEL-DAGGETT	SW	03	T076	R29W				5	5	15	
											5	12	
											4	14B	
A61006	SCHILDBERG CONST CO INC	92 QUARRY	SW	05	T075	R29W				5	5	15	
A61010	MARTIN MARIETTA	EARLHAM	N2	09	T077	R28W					5	25E	
A61012	MARTIN MARIETTA	WINTERSET NORTH	SE	27	T076	R27W					5	25	
A61013	SCHILDBERG CONST CO INC	WINTERSET WEST	SW	28	T076	R27W					5	25E	
A61016	PERU QUARRY	PERU	NE	27	T075	R27W							
A61018	MARTIN MARIETTA	PAMMEL		08	T075	R28W				5	5	15	
A61024	MARTIN MARIETTA	PENN-DIXIE	SW	32	T076	R27W					5	25	
A61026	MARTIN MARIETTA	MASON	SW	16	T077	R28W					4	20	
											5	25	
A61028	GRIMES ASPHALT & PAVING	GRIMES ASPHALT & PAV	SE	04	T074	R27W					5	25	
A61032	MARTIN MARIETTA	THRAILKILL	NE	08	T077	R28W					4	20	
											5	25	
A61034	BIG STONES QUARRY INC	CLANTON CREEK	NW	10	T074	R27W							
A61036	SCHILDBERG CONST CO INC	MONARCH CEMENT OF IOWA	NE	08	T077	R28W						25B-25E	
62	**MAHASKA DIST 5**	**CRUSHED STONE**											
A62008	MARTIN MARIETTA	GIVEN #2	SE	14	T074	R16W							
		SAND & GRAVEL											
A62502	SKYLINE CONST CO	G71	SW	15	T074	R16W	2.67		X				

RECENTLY ACTIVE AGGREGATE SOURCES

CODE	OPERATOR	SOURCE NAME	LOCATION	BULK SSD SpGr	DUR PCC CA	FA	FRICT HMA A	B	BEDS	T E
63	**MARION DIST 5**	**CRUSHED STONE**								
A63002	MARTIN MARIETTA	DURHAM MINE	NE 08 T075 R18W	DWU	3i		4	4	101	
				2.59	2		4	4	88 - 95	
							4	4	95 - 96	1
A63010	BRUENING ROCK PROD INC	S&S	SE 25 T075 R20W					4		
		SAND & GRAVEL								
A63502	PELLA CONST CO LTD	BEAN PROPERTY	NE 02 T075 R18W				4	4		
				2.67		X				
A63512	MARTIN MARIETTA	NEW HARVEY	NW 12 T075 R18W	2.67		X				
64	**MARSHALL DIST 1**	**CRUSHED STONE**								
A64002	MARTIN MARIETTA	FERGUSON	SW 05 T082 R17W	2.65	3i		4	4	10 - 21	
				2.66	3		4	4	10 - 17	
				DWU	2		4	4	8 - 17	
				2.66	2		4	4	8 - 21	
				DWU	2		4	4	2 - 17	
							4	4	1 - 18	
A64004	CESSFORD CONST CO	LE GRAND	SW 36 T084 R17W	2.58	3i		5	5	1 - 7	
							4	4	8 - 27	
		SAND & GRAVEL								
A64502	MARTIN MARIETTA	MARSHALLTOWN	SW 29 T084 R17W	2.66	2		4	4		
				2.65		X				
A64506	KNIFE RIVER	BEACH	NW 09 T085 R20W					X		
65	**MILLS DIST 4**	**CRUSHED STONE**								
A65006	SCHILDBERG CONST CO INC	MALVERN	NW SE 31 T072 R41W					X		
66	**MITCHELL DIST 2**	**CRUSHED STONE**								
A66002	FALK CONST CO	DUENOW	SE 08 T099 R17W	2.77	3iB				5	
					3				13	
							4	4	1 - 5	
							4	4	7 - 13	
A66006	FALK CONST CO	WILDE	NE 07 T098 R18W					5		
A66014	FALK CONST CO	STAFF	NE 17 T097 R17W	DWU	3i				3	
A66016	FALK CONST CO	LESCH	SW 12 T097 R17W	DWU	3i				6 - 7	
							5	5	1 - 8	
							4	4	9 - 14	
A66018	FALK CONST CO	DYNES	SW 30 T099 R15W							
A66020	FALK CONST CO	ASPEL	NE 03 T099 R15W							
A66022	FALK CONST CO	WAGNER	NW 29 T098 R16W		X		X	X		
A66024	FALK CONST CO	GRUNDEL	07 T098 R18W							
A66026	R D SMITH ENTERPRISE	KOSTER	NE 35 T099 R18W							
		SAND & GRAVEL								
A66502	FALK CONST CO	OSAGE-SCHMIDT	NW 01 T097 R17W				4	4		
				2.63		X				
A66504	FALK CONST CO	ST ANSGAR-BLAZEK	SW 36 T099 R18W				3	3		
A66510	FALK CONST CO	NEWBURG	NW 26 T099 R18W				3	3		
A66512	FALK CONST CO	KLAAHSEN	SW 36 T099 R18W	2.66		X				
A66514	FALK CONST CO	LOVIK	SE SW 12 T097 R17W	2.65		X				

NOTE 1: BOTTOM 5.0' ONLY OF BED 95

RECENTLY ACTIVE AGGREGATE SOURCES

CODE	OPERATOR	SOURCE NAME	LOCATION				BULK SSD SpGr	DUR PCC CA	FA	FRICT HMA A	B	BEDS	NOTE
67	**MONONA DIST 3**	**SAND & GRAVEL**											
A67502	HALLETT MATERIALS CO	RODNEY		02	TO85	R44W	DWU	2		3	3		
							DWU		X				
A67506	HARGRAVE	HARGRAVE	NE	31	TO85	R46W				4	4		
A67508	MIDWEST PAVING CO	ONAWA	SW	09	TO82	R45W				4	4		
68	**MONROE DIST 5**	**CRUSHED STONE**											
A68004	DOUDS STONE INC	EDDYVILLE SOUTH	SW	02	TO73	R16W							
69	**MONTGOMERY DIST 4**	**CRUSHED STONE**											
A69002	SCHILDBERG CONST CO INC	STENNETT	NE	27	TO73	R38W					4	16 - 17	
A69006	NATURAL MATERIALS	RED OAK	NW	12	TO72	R39W					4	9	
		SAND & GRAVEL											
A69504	WESTERN ENGINEERING	ELLIOT		13	TO73	R38W				4	4		
70	**MUSCATINE DIST 5**	**CRUSHED STONE**											
A70002	WENDLING QUARRIES INC	MOSCOW	NW	08	TO78	R02W	2.66	3i		5	5	11 - 17	
							2.67	3iB		4	4	21A- 24	
										5	5	8 - 17	
											5	1 - 9	
A70006	TUBE CITY IMS CORPORATION	WILTON	SE	02	TO78	R02W				2	2		
A70008	HARSCO CORP/HECKETT DIV	MONTPELIER	SE	11	TO77	R01E				2	2		
		SAND & GRAVEL											
A70504	WENDLING QUARRIES INC	ATALISSA-MCKILLIP	NW	20	TO78	R02W				4	4		
							2.66		X				
A70506	ACME FUEL AND MATERIALS	ACME	SE	22	TO76	R02W	2.65		X				
A70508	HAHN S&G	HAHN	SE	16	TO76	R02W							
A70510	NORTHERN GRAVEL CO	NORTHERN		15	TO76	R02W							
71	**O'BRIEN DIST 3**	**SAND & GRAVEL**											
A71508	MARTIN MARIETTA	SHELDON	SW	16	TO97	R42W				4	4		
A71510	MARTIN MARIETTA	OPEN	SE	29	TO97	R42W				4	4		
A71512	MARTIN MARIETTA	SANBORN	SW	04	TO96	R41W				4	4		
A71514	MARTIN MARIETTA	PAULLINA	SE	23	TO95	R41W				4	4		
A71516	MARTIN MARIETTA	OPEN	SE	01	TO94	R41W				4	4		
A71518	MARTIN MARIETTA	OPEN		17	TO95	R39W				4	4		
A71520	MARTIN MARIETTA	PRIMGHAR	NW	04	TO95	R39W				4	4		
A71522	FABER & SON CONST CO	SHELDON	SE	19	TO97	R42W				4	4		
A71526	MARTIN MARIETTA	OPEN	SE	20	TO97	R42W				4	4		
A71528	O'BRIEN COUNTY	COUNTY	NW	27	TO95	R39W				4	4		
A71530	ROHLIN CONST CO	ROHLIN		14	TO97	R42W				4	4		
A71532	KNIFE RIVER	DOUMA	SE	05	TO96	R41W							
A71534	HALLETT MATERIALS CO	SHELDON/KLEINWALTERINK	CT	16	TO97	R42W							

RECENTLY ACTIVE AGGREGATE SOURCES

CODE	OPERATOR	SOURCE NAME	LOCATION						BULK SSD SpGr	DUR PCC CA	FA	FRICT HMA A	B	BEDS	T E
72	**OSCEOLA DIST 3**	**SAND & GRAVEL**													
A72504	NORTHWEST R/M CONC INC	OCHEYEDAN	SE	15	SW	14	TO99	R40W	2.71	2		3	3		
									2.68		X				
A72506	HALLETT MATERIALS CO	ASHTON			SW	28	TO98	R42W	2.69	2		3	3		
									2.69		X				
A72508	MARTIN MARIETTA	THOMAS			NW	36	TO99	R40W				4	4		
A72514	MARTIN MARIETTA	OPEN			NW	31	T100	R40W				4	4		
A72518	FABER & SON CONST CO	VASS				19	T100	R42W				4	4		
A72520	NORTHWEST R/M CONC INC	OCHEYEDAN NORTH			NE	23	TO99	R40W				4	4		
A72522	HIGMAN SAND & GRAVEL	KAPPES			NE	11	TO98	R42W	DWU	2					
											X				
A72524	KNIFE RIVER	BOERHAVE			SE	21	TO98	R42W	DWU		X				
A72526	NORTHWEST R/M CONC INC	OCHEYEDAN SOUTH				19	TO99	R39W							
A72528	KNIFE RIVER	DIRKS			SW	36	TO99	R40W							
A72530	NORTHWEST R/M CONC INC	BOYD			NW	36	TO99	R40W	2.65	2					
									2.66		X				
A72532	HALLETT MATERIALS CO	OCHEYEDAN			NW	14	TO99	R40W							
73	**PAGE DIST 4**	**CRUSHED STONE**													
A73004	SCHILDBERG CONST CO INC	SHAMBAUGH			SW	20	TO67	R36W					4		
		SAND & GRAVEL													
A73508	HALLETT MATERIALS CO	SHENANDOAH-CONNELL II			NE	07	TO69	R39W	DWU	2					
									2.63		X				
74	**PALO ALTO DIST 3**	**SAND & GRAVEL**													
A74502	HALLETT MATERIALS CO	EMMETSBURG S&G				36	TO96	R33W	2.71	2		3	3		
									2.64		X				
A74504	MARTIN MARIETTA	DORWEILLER			SW	05	TO94	R31W				3	3		
									2.67		X				
A74506	MARTIN MARIETTA	WEST BEND			NW	08	TO94	R31W				3	3		
A74508	MARTIN MARIETTA	OPEN			NW	10	TO97	R33W				4	4		
A74509	HOFFERT S&G	EMMETSBURG			NW	22	TO96	R33W	2.69	2		4	4		
									2.66		X				
A74512	ROHLIN CONST CO INC	KAY			SW	20	TO96	R31W							
75	**PLYMOUTH DIST 3**	**SAND & GRAVEL**													
A75502	HIGMAN SAND & GRAVEL	AKRON			NW	01	TO92	R49W	2.70	2		3	3		
									2.67		X				
A75503	EVERIST INC	AKRON			NE	01	TO92	R49W	2.69	2		3	3		
									2.67		X				
A75506	MARTIN MARIETTA	REMSEN			SE	03	TO92	R44W				4	4		
A75508	MARTIN MARIETTA	ASPEN			NE	11	TO92	R49W				3	3		
A75510	MARTIN MARIETTA	KINGSLEY			NE	35	TO90	R44W				4	4		
A75512	HYMANS CONST CO	KINGSLEY			NE	13	TO90	R44W				4	4		
A75514	WALKERS EXCAVATING CO	OYENS				05	TO92	R44W				3	3		
A75516	HALLETT MATERIALS CO	BRUNSVILLE				03	TO92	R46W				4	4		
A75518	HALLETT MATERIALS CO	HINTON			NW	16	TO90	R46W	DWU	3		3	3		
A75520	HALLETT MATERIALS CO	MERRILL				02	TO91	R46W				4	4		
A75522	ROHLIN CONST CO INC	THOMS				26	TO92	R46W							
A75524	L&M SAND & GRAVEL INC	G DIRKSEN #2				31	TO93	R44W	2.65		X				
A75526	L&M SAND & GRAVEL INC	FRITZ DIRKSEN				05	TO92	R44W	DWU		X				
A75528	HIGMAN SAND & GRAVEL	LEMARS				04	TO92	R45W	DWU		X				

RECENTLY ACTIVE AGGREGATE SOURCES

CODE	OPERATOR	SOURCE NAME	LOCATION				BULK SSD SpGr	DUR PCC CA	FA	FRICT HMA A	B	BEDS	NOTE
76	**POCAHONTAS DIST 3**	**CRUSHED STONE**											
A76002	MARTIN MARIETTA	GILMORE CITY	NE	36	T092	R31W	2.64	3iB		5	5	1A - 3	
										4	4	1B - 3	
A76004	MARTIN MARIETTA	MOORE	SW	25	T092	R31W	2.65	3iB		5	5	1A - 3	
										4	4	3	
										4	4	1B - 3	
										4	4	4 - 10	
										5	5	4 - 12	
		SAND & GRAVEL											
A76506	MARTIN MARIETTA	EGLE	NE	02	T090	R31W				4	4		
A76508	MARTIN MARIETTA	OPEN	NE	07	T091	R33W				4	4		
A76510	MARTIN MARIETTA	ZEAMAN	SE	13	T092	R31W				4	4		
A76512	MARTIN MARIETTA	LIZARD CREEK		13	T090	R31W				4	4		
A76514	BLACKTOP SERVICES	MILLER		12	T093	R31W	DWU		X	4	4		
77	**POLK DIST 1**	**SAND & GRAVEL**											
A77502	MARTIN MARIETTA	JOHNSTON	NW	17	T079	R24W	DWU	2		3	3		
							2.67		X				
A77504	HALLETT MATERIALS CO	DENNY-JOHNSTON		08	T079	R24W	2.70	2		3	3		
							2.67		X				
A77508	HALLETT MATERIALS CO	EDM #1-WHITE	SE	18	T078	R23W							
A77514	HALLETT MATERIALS CO	WEST DES MOINES	SE	29	T078	R25W							
A77520	MARTIN MARIETTA	ARMY POST ROAD	SW	29	T078	R25W	2.65	2		3	3		
							2.66		X				
A77522	HALLETT MATERIALS CO	EDM #2-VANDALIA	NE 07 NW	08	T078	R23W	2.69	2		3	3		
							2.65		X				
A77526	HALLETT MATERIALS CO	ARMY POST EAST	SE	29	T078	R25W	2.66	2		3	3		
							2.65		X				
A77528	HALLETT MATERIALS	PLEASANT HILL		08	T078	R23W	2.68	2		3	3		
							2.66		X				
A77530	HALLETT MATERIALS CO	NORTH DES MOINES	NE	16	T079	R24W	2.67	2					
							2.66		X				
A77532	LOUNSBURY S&G	WEST DES MOINES		30	T078	R25W							
A77534	MARTIN MARIETTA	SAYLORVILLE SAND		09	T079	R24W	2.66		X				
78	**POTTAWATTAMIE DIST 4**	**CRUSHED STONE**											
A78002	SCHILDBERG CONST CO INC	CRESCENT		35	T076	R44W				4	4	25B-25E	
										4	4	25C-25E	
											4	25A-25C	
											5	25F	
											4	26A-26E	
											4	27A-27B	
A78006	SCHILDBERG CONST CO INC	MACEDONIA-K&S	NE	28	T074	R40W					4		
		SAND & GRAVEL											
A78504	WESTERN ENGRG CO INC	OAKLAND	SW	23	T075	R40W	2.65	3		4	4		
							2.65		X				
A78506	SCHILDBERG CONST CO INC	CRESCENT	NE	34	T076	R44W				4	4		
79	**POWESHIEK DIST 1**	**CRUSHED STONE**											
A79002	MARTIN MARIETTA	MALCOM MINE	SE	04	T080	R15W	2.60	2		4	4	10 - 13	
80	**RINGGOLD DIST 4**	**CRUSHED STONE**											
A80002	SCHILDBERG CONST CO INC	WATTERSON	SE	19	T067	R29W					5	7	

RECENTLY ACTIVE AGGREGATE SOURCES

CODE	OPERATOR	SOURCE NAME	LOCATION				BULK SSD SpGr	DUR PCC CA	FA	FRICT HMA A	B	BEDS	T E
81	**SAC DIST 3**	**SAND & GRAVEL**											
A81502	HALLETT MATERIALS CO	SACTON-LAKEVIEW	S2	08	T086	R36W	2.72	3		3	3		
							2.67		X				
A81504	HALLETT MATERIALS CO	AUBURN	NW	02	T086	R35W	2.68	2		4	4		
							2.64		X				
A81506	HALLETT MATERIALS CO	SAC CITY	NW	36	T088	R36W				4	4		
							DWU		X				
A81508	LAKE VIEW CONCRETE PROD	LAKEVIEW	SE	05	T086	R36W				4	4		
A81514	TIEFENTHALER INC	CARNARVON S&G	NE	16	T086	R36W	2.68	2		3	3		
							2.66		X				
A81520	KNIFE RIVER	UREN	SE	11	T087	R36W				3	3		
							2.67		X				
A81522	HALLETT MATERIALS CO	ULMER	SW	28	T087	R35W				4	4		
A81524	KNIFE RIVER	NO NAME	SE	04	T087	R37W				4	4		
A81526	MARTIN MARIETTA	BETTIN		19	T087	R36W				4	4		
A81528	HALLETT MATERIALS CO	WALL LAKE	NW	18	T086	R36W	2.70	3					
							2.67		X				
A81530	HALETT MATERIALS CO	LEITZ NORTH	SE	29	T087	R35W	DWU		X				
A81532	HIGMAN SAND & GRAVEL	EARLY-THORPE		22	T089	R37W	DWU	2		4	4		
							2.66		X				
A81534	MARTIN MARIETTA	SAC COUNTY S&G	SE SE	22	T089	R37W	2.68		X				
A81536	TIEFENTHALER INC	DAIKER	NE	12	T086	R35W	DWU		X				
A81540	TIEFENTHALER INC	COLBURN		13	T087	R35W							
82	**SCOTT DIST 6**	**CRUSHED STONE**											
A82002	RIVERSTONE GROUP INC	MCCAUSLAND (MC 39)	W2	17	T080	R04E	DWU	3i		4	4	17 - 19*	
							DWU	3		4	4	1 - 16	
A82004	RIVERSTONE GROUP INC	NEW LIBERTY (MC 41)	NE	33	T080	R01E	DWU	3iB		4	4	1 - 2	1
A82006	RIVERSTONE GROUP INC	LECLAIRE (MC 38)	NW	35	T079	R05E	2.71	3i				14 - 27	
							DWU	3i				28 - 29	
							DWU	3				2 - 13	
										4	4	1 - 28	
A82008	LINWOOD MINING & MINERALS	LINWOOD MINE	SW	13	T077	R02E	2.67	3i		5	5	20 - 25	
							2.69	3i		5	5	27 - 30B	
							DWU	3i		4	4	33 - 41	
							DWU	3		5	5	19	
										4	4	24 - 25	
		SAND & GRAVEL											
A82502	RIVERSTONE GROUP INC	MCCAUSLAND (MC 43)	SW	17	T080	R05E				4	4		
							2.66		X				
83	**SHELBY DIST 4**	**SAND & GRAVEL**											
A83506	HALLETT MATERIALS CO	HARLAN-REINIG	NW	30	T079	R38W	2.65	3					
							2.65		X				
A83508	NATURAL MATERIALS	JACKSONVILLE		12	T079	R37W							

* TOP 32' OF BED 19
NOTE 1: 1.25-INCH MAXIMUM TOP SIZE

RECENTLY ACTIVE AGGREGATE SOURCES

CODE	OPERATOR	SOURCE NAME	LOCATION					BULK SSD SpGr	DUR PCC CA	FA	FRICT HMA A	B	BEDS	NOTE
84	**SIOUX DIST 3**	**SAND & GRAVEL**												
A84502	VALLEY SAND AND GRAVEL	VANZEE		NW	20	TO97	R46W	2.69	2		3	3		
								2.67		X				
A84504	HYMANS CONST CO	VANDERESCH		SE	20	TO96	R47W	DWU	2		3	3		
A84506	HALLETT MATERIALS CO	HUDSON-OSTERCAMP		SE	07	TO96	R47W				3	3		
								2.69		X				
A84508	JOE'S READY MIX INC	SIOUX CENTER		NW	33	TO95	R45W				4	4		
								DWU		X				
A84510	EVERIST INC	HAWARDEN-NORTH	S2	NW	22	TO95	R48W	2.70	2		3	3		
								2.67		X				
A84511	HYMANS CONST CO	HAWARDEN		NE	01	TO95	R48W	DWU	2		3	3		
A84514	BOYDEN	COUNTY			35	TO97	R44W				4	4		
A84516	MARTIN MARIETTA	NO NAME			25	TO97	R48W							
A84518	MARTIN MARIETTA	ALTON		SE	15	TO94	R44W				4	4		
A84520	COUNTY PIT	CHATSWORTH		SW	28	TO94	R48W				4	4		
A84522	HALLETT MATERIALS CO	HYMAN		SW	31	TO96	R47W							
A84524	VALLEY SAND AND GRAVEL	GROTH		NW	36	TO97	R48W				4	4		
A84526	BEDROCK GRAVEL CO	JONAS		NE	36	TO94	R44W	DWU		X	4	4		
A84528	HIGMAN S&G	HIGMAN-CHATSWORTH		W2	28	TO94	R48W	2.69	2		4	4		
								DWU		X				
A84530	VALLEY SAND AND GRAVEL	GROENWEG		NW	15	TO97	R46W	DWU	2		3	3		
								DWU		X				
A84532	KNIFE RIVER	LASSON			32	TO94	R44W	DWU	2					
								DWU		X				
A84534	KNIFE RIVER	CLEVERINGA		SE	25	TO95	R44W							
5	**STORY DIST 1**	**CRUSHED STONE**												
A85006	MARTIN MARIETTA	AMES MINE		SW	24	TO84	R24W	2.57	3i		5	5	19 - 25	
											4	4	26,28- 39	1
								2.68	3iB		4	4	47	
		SAND & GRAVEL												
A85510	HALLETT MATERIALS CO	AMES SOUTH			18	TO83	R23W	2.66	2		3	3		
								2.65		X				
86	**TAMA DIST 1**	**CRUSHED STONE**												
A86002	WENDLING QUARRIES INC	MONTOUR		NW	09	TO83	R16W	2.61	3i		5	5	1 - 7	
								2.63	3i		4	4	13 - 20	
											4	4	8 - 12	
		SAND & GRAVEL												
A86502	MANATT'S INC	FLINT		NW	03	TO82	R15W				3	3		
								2.65		X				
87	**TAYLOR DIST 4**	**CRUSHED STONE**												
A87004	SCHILDBERG CONST CO INC	102 QUARRY		NE	32	TO68	R34W					4		
88	**UNION DIST 4**	**CRUSHED STONE**												
A88002	SCHILDBERG CONST CO INC	THAYER		NE	35	TO72	R28W					5	25A-25E	
												5	25E	

NOTE 1: THE CONTENT OF BED 26 SHALL NOT BE MORE THAN 50% IN THE OVERALL PRODUCT.

RECENTLY ACTIVE AGGREGATE SOURCES

CODE	OPERATOR	SOURCE NAME	LOCATION				BULK SSD SpGr	DUR PCC		FRICT HMA		BEDS	T E
								CA	FA	A	B		
89	**VAN BUREN DIST 5**	**CRUSHED STONE**											
A89002	DOUDS STONE INC	DOUDS MINE	SE	25	TO70	R11W	2.46	2		4	4	6 - 13	
A89006	CESSFORD CONST CO	FARMINGTON-COMANCHE	NE	05	TO67	R08W	2.69	3i		5	5	3	
							2.52	2		4	4	16 - 17	
											4	18 - 22	
										5	5	5 - 12	
A89008	DOUDS STONE INC	SELMA-GARDNER	NW	16	TO70	R11W	2.69	3		4	4	11	
										5	5	7 - 10	
											5	7 - 11	
										4	4	14 - 21	
										4	4	22 - 31	
90	**WAPELLO DIST 5**	**SAND & GRAVEL**											
A90504	DOUDS STONE INC	HOFFMAN	SE	10	TO72	R14W				4	4		
							2.65		X				
92	**WASHINGTON DIST 5**	**CRUSHED STONE**											
A92002	DOUDS STONE INC	WEST CHESTER	NE	19	TO76	R08W	2.64	3		4	4	5 - 7	
							DWU	2				14 - 16	
A92006	DOUDS STONE INC	COPPOCK	NE	30	TO74	R07W				5	5	3 - 4	
A92008	RIVER PRODUCTS CO	PEPPER-KEOTA FIELD	SW	31	TO76	R09W							
A92014	DOUDS STONE INC	COPPOCK NORTH	SE	19	TO74	R07W							
		SAND & GRAVEL											
A92502	RIVER PRODUCTS CO	RIVERSIDE	NE	10	TO77	R06W				4	4		
							2.65		X				
94	**WEBSTER DIST 1**	**CRUSHED STONE**											
A94002	MARTIN MARIETTA	FT DODGE MINE	SW	24	TO89	R29W	2.65	3iB		4	4	36 - 42	
A94006	MARTIN MARIETTA	YATES	SW	01	TO89	R29W					5		
A94008	KNIFE RIVER	BUSKE	SE	36	TO90	R29W				5	5	1 - 11	
		SAND & GRAVEL											
A94502	NORTHWEST MATERIALS	YATES	SW	01	TO89	R29W				4	4		
							2.66		X				
A94522	AUTOMATED S&G	CROFT	NW	14	TO89	R29W	2.65		X				
A94526	KNIFE RIVER	BUSKE	SE	36	TO90	R29W				3	3		
							2.67		X				
A94528	KNIFE RIVER	CONDON	NW	19	TO90	R30W							

RECENTLY ACTIVE AGGREGATE SOURCES

CODE	OPERATOR	SOURCE NAME	LOCATION				BULK SSD SpGr	DUR PCC CA	FA	FRICT HMA A	B	BEDS	NOTE
96	**WINNESHIEK DIST 2**	**CRUSHED STONE**											
A96002	ROVERUD CONST INC	KENDALLVILLE	NE	33	T100	R10W	2.68	3B		4	4	3 - 7	
											4	1 - 7	
A96003	WILTGEN CONST CO	BROWN	NW	08	TO99	R10W							
A96004	ROVERUD CONST INC	HOVEY	SW	28	TO98	R08W	2.64	3B		4	4	1 - 4	
										4	4	1 - 6	
A96005	BRUENING ROCK PROD INC	MCGEE	NW	19	TO99	R10W							
A96007	WILTGEN CONST CO	JACKSON	NE	31	TO96	R10W							
A96008	BRUENING ROCK PROD INC	WELKEN	SW	04	TO98	R07W	2.71	3i		4	4	4 - 8	
A96009	ROVERUD CONST INC	DRACKLEY		15	TO99	R08W							
A96010	ROVERUD CONST INC	ANDERSON	SW	22	T100	R10W	2.65	3B		5	5	1 - 4	
A96014	NIEMANN CONST CO	FESTINA	SW	26	TO96	R09W		X		5	5	1 - 3	
A96016	BRUENING ROCK PROD INC	SKYLINE A	SE	10	TO98	R08W	2.66	3B		5	5	1 - 3	
										4	4	4 - 8	
A96017	BRUENING ROCK PROD INC	SKYLINE B	CT	10	TO98	R08W	2.66	3B		5	5	1 - 3	
										4	4	4 - 11	
A96022	WILTGEN CONST CO	MADISON #2	NE	18	TO98	R08W					5		
A96025	WILTGEN CONST CO	MADISON #1	NW	17	TO98	R08W					4		
A96030	ROVERUD CONST INC	ASK	NE	27	TO98	R07W					4		
A96032	ROVERUD CONST INC	BRUVOLD	NW	20	TO98	R07W					X		
A96034	BRUENING ROCK PROD INC	THOMPSON	SE	29	TO98	R09W							
A96038	ROVERUD CONST INC	NORDNESS	SE	09	TO97	R08W					X		
A96040	ROVERUD CONST INC	LOCUST	NE	11	TO99	R08W					X		
A96046	BRUENING ROCK PROD INC	SERSLAND-SMORSTAD	SE	09	TO97	R07W				X	X		
A96048	NIEMANN CONST CO	LOVE #1	NW	30	TO96	R10W					X		
A96049	NIEMANN CONST CO	LOVE #2	SW	30	TO96	R10W					X	1 - 10	
A96050	BRUENING ROCK PROD INC	BULLERMAN-FESTINA	SE	14	TO96	R09W					4	1 - 3	
A96052	ROVERUD CONST INC	ESTREM	SW	04	TO97	R07W	2.63	3B				1 - 6	
										5	5	1 - 8	
A96054	ROVERUD CONST INC	HORSESHOE BEND	SW	20	TO97	R09W					X		
A96058	BRUENING ROCK PROD INC	BROGHAMMER	SE	26	TO99	R08W					X		
A96060	ROVERUD CONST INC	BURR OAK	SE	23	T100	R09W				4	4		
A96062	ROVERUD CONST INC	HOLT HAUS	SE	28	TO98	R08W					X		
A96064	ROVERUD CONST INC	STIKA	NW	15	TO97	R10W	DWU	3i		4	4	1 - 4A	
A96066	BRUENING ROCK PROD INC	KROSHUS	SW	13	T100	R07W					X		
A96068	BRUENING ROCK PROD INC	HOLKESVIK	SW	01	TO99	R08W							
A96070	WILTGEN CONST CO	KUHN	NW	33	TO96	R08W							
A96072	BRUENING ROCK PROD INC	MCKENNA NORTH	SW	34	T100	R09W							
A96074	WILTGEN CONST CO	OSSIAN	SW	21	TO96	R08W							
A96076	ROVERUD CONST INC	PRASKA	NE	19	TO97	R10W							
A96078	BRUENING ROCK PROD INC	BUSTA	NW	30	TO96	R10W							
A96082	WILTGEN CONST CO	CROW	SW	17	TO97	R10W							
A96084	WILTGEN CONST CO	YOUNG	SE	28	T100	R08W							
A96086	BRUENING ROCK PROD INC	BRUVOLD	NE	29	TO98	R07W							
A96090	BRUENING ROCK PROD INC	MCKENNA SOUTH	SE	28	TO99	R09W	DWU	3iB		5	5	1 - 5	
A96092	ROVERUD CONST INC	HANSON	SE	26	T100	R08W							
A96094	ROVERUD CONST INC	CAROLAN	SE	27	TO99	R09W							
A96100	WILTGEN CONST CO	YOUNG	NE	05	TO98	R07W							
		SAND & GRAVEL											
A96502	CARLSON MATERALS CO	DECORAH	NE	22	TO98	R08W				4	4		
							2.63		X				
A96506	ROVERUD CONST INC	FREEPORT	NE	07	TO98	R07W	2.65		X				
A96514	ROVERUD CONST INC	ELSBERND	NE	16	TO96	R09W				4	4		
							2.66		X				
A96520	CARLSON MATERIALS CO	SWEDES BOTTOM	NE	06	TO98	R08W	2.63		X	4	4		
A96522	BRUENING ROCK PROD INC	WOHLSEORS	NW	17	TO98	R10W							
A96526	ROVERUD CONST INC	STIKA	NW	15	TO98	R08W							

RECENTLY ACTIVE AGGREGATE SOURCES

CODE	OPERATOR	SOURCE NAME	LOCATION				BULK SSD SpGr	DUR PCC		FRICT HMA		BEDS	T E
								CA	FA	A	B		
96	**WINNESHIEK DIST 2**	**SAND & GRAVEL *(CONTINUED)***											
A96528	BRUENING ROCK PROD INC	GJETLEY	NE	08	TO98	R07W				4	4		
A96530	CARLSON MATERIALS CO	CARLSON-FREEPORT	NE	13	TO98	R08W	2.63		X				
A96532	WILTGEN CONST CO	SCHMITT	NE	34	TO96	R09W	DWU		X	3	3		
97	**WOODBURY DIST 3**	**SAND & GRAVEL**											
A97502	HALLETT MATERIALS CO	CORRECTIONVILLE-BUCK	NW	13	TO89	R42W				3	3		
							DWU		X				
A97508	MARTIN MARIETTA	CORRECTIONVILLE #2	NW	35	TO89	R42W				3	3		
A97510	HALLETT MATERIALS CO	CORRECTIONVILLE-COCKBURN	SE	11	TO88	R43W				3	3		
A97514	PERSINGER S&G	SMITHLAND	NW	25	TO86	R44W				3	3		
							DWU		X				
A97516	HALLETT MATERIALS CO	ANTHON		05	TO87	R43W	2.72	3		3	3		
							2.67		X				
A97518	HALLETT MATERIALS CO	SMITHLAND		35	TO86	R44W	2.69	3		3	3		
							2.67		X				
A97520	HALLETT MATERIALS CO	CORRECTIONVILLE-BREESIE		01	TO88	R43W				4	4		
A97526	FLEWELLING S&G	FLEWELLING	NW	10	TO89	R44W	2.67		X				
A97528	HALLETT MATERIALS CO	EDWARD	SE	23	TO89	R42W							
A97530	NELSTAR	NELSTAR		14	TO88	R43W							
A97532	KNIFE RIVER	CREASEY	SE	09	TO89	R44W							
98	**WORTH DIST 2**	**CRUSHED STONE**											
A98002	MARTIN MARIETTA	HARRIS	SW	29	T100	R20W	DWU	3i		4	4	10	
							2.73	3B		4	4	6 - 7	
							DWU	3		4	4	6 - 11	
							DWU	2				2 - 11	
										4	4	2 - 10	
A98010	BMC AGGREGATES LC	FERTILE	SW	36	TO98	R22W	2.73	3B		4	4	15 - 20	
							DWU	2B				15 - 29	
							DWU	2B				22 - 29	
											4	5 - 10	
										4	4	5 - 20	
A98014	FALK CONST CO	STEVENS	NW	01	TO98	R20W	2.77	3				8 - 11B	
											5	1 - 3	
										4	4	4 - 7	
A98016	ULLAND BROS CONST	EMIL OLSON-BOLTON	SW	10	TO99	R20W	DWU	2				2 - 5A	
								X		4	4	3 - 7	
											5	1 - 7	
A98020	FALKSTONE	TRENHAILE	W2 NE	09	TO99	R20W	DWU	2				2	
		SAND & GRAVEL											
A98502	RANDALL TRANSIT MIX	RANDALL TRANSIT MIX	NW	31	T100	R20W				4	4		
							2.66		X				
A98504	BMC AGGREGATES LC	FERTILE	NW	36	TO98	R22W				3	3		
							2.65		X				
A98506	MARTIN MARIETTA	KNUTSON	SW	30	T100	R20W				4	4		
A98518	FALK CONST CO	COOPER	NE	12	TO98	R20W					4		
A98522	ULLAND BROS CONST	EMIL OLSON-BOLTON	SW	10	TO99	R20W							

RECENTLY ACTIVE AGGREGATE SOURCES

CODE	OPERATOR	SOURCE NAME	LOCATION				BULK SSD SpGr	DUR PCC CA	FA	FRICT HMA A	B	BEDS	NOTE
99	**WRIGHT DIST 2**	**CRUSHED STONE**											
A99002	BECKER GRAVEL	VOSS		36	T090	R26W	2.59	3i		4	4	8	
		SAND & GRAVEL											
A99502	WRIGHT MATERIALS	WRIGHT	NW	12	T093	R24W	2.65	2		3	3		
							2.63		X				
A99510	MARTIN MARIETTA	MEINEKE	NE	14	T090	R23W				4	4		
							DWU		X				
A99514	KNIFE RIVER	VOSS		36	T090	R26W							
A99516	GIESE CONST CO	MCALPINE		24	T092	R24W							
A99518	KNIFE RIVER	REICHTER	SE	06	T092	R26W							
A99520	KNIFE RIVER	DENNIS PETERSON	NE	15	T090	R23W							
IL	**ILLINOIS**	**CRUSHED STONE**											
AIL002	CESSFORD CONST CO	BIGGSVILLE, HENDERSON CO		17	T010	R04W				4	4		
AIL006	RIVERSTONE GROUP INC	MIDWAY (MC 45), ROCK ISLAND CO	SW	16	T018	R02E	DWU	3iB		4	4	1 - 5	
AIL008	RIVERSTONE GROUP INC	MCMAHON (MC 08), WHITESIDE CO	NE	11	T020	R02E							
AIL010	RIVERSTONE GROUP INC	ALLIED (MC 30), ROCK ISLAND CO		14	T017	R02W	DWU	3i		4	4	18	
							2.69	3		5	5	7 - 13	
							DWU	3				14	
							2.72	3		4	4	16 - 17	
AIL012	MATERIAL SERVICES	OTTAWA-LIGHTWEIGHT								4	4		
AIL014	CESSFORD CONST CO	DALLAS CITY, HENDERSON CO	SW	36	T008	R07W	2.63	3i		4	4	5B	1
											4	2 - 3	
AIL016	RIVERSTONE GROUP INC	CLEVELAND (MC 31), HENRY CO	SW	31	T017	R02E	DWU	3i		4	4		
AIL018	MEDUSA AGGREGATES	KANKAKEE, KANKAKEE CO	NW	07	T030	R14W	DWU	2					
[illegible]IL020	GRAY QUARRIES/W L MILLER	HAMILTON, HANCOCK CO	NE	31	T005	R08W	2.65	3		4	4	2	1
							DWU	3		4		4	
							DWU	2				7	
AIL026	REIN SCHULTZ & DAHL	EMERSON	SE	13	T021	R06E					4		
AIL028	WENDLING QUARRIES INC	TURNBAUGH-MT CARROLL, IL	SW	10	T024	R04E	DWU	3		4	4	3 - 7	
AIL030	WENDLING QUARRIES INC	HUIZENGA	NW	21	T021	R03E					4		
AIL032	GALENA STONE CO	EUSTICE, JO DAVIESS CO	NE	16	T027	R02E							
AIL034	GALENA STONE CO	VIRTUE, JO DAVIESS CO	W2	24	T028	R02W							
AIL038	COOTS MATERIALS CO INC	ROTH, JO DAVIESS CO	SW	35	T029	R02W							
AIL040	COOTS MATERIALS CO INC	MONMOUTH, WARREN CO	NW	06	T011	R02W							
		SAND & GRAVEL											
AIL502	RIVERSTONE GROUP INC	ALBANY (MC@511), ROCK IS CO	SW	34	T020	R02E	2.65	3i		3	3		
							2.67		X				
AIL504	RIVERSTONE GROUP INC	BIG ISLAND (MC 51), ROCK IS CO		16	T017	R02W	2.67	3		3	3		
							2.67		X				
AIL506	ILLINOIS-WISCONSIN S&G	SOUTH BELOIT	NW	08	T016	R02E				4	4		
AIL508	RIVERSTONE GROUP INC	BARSTOW (MC 52), ROCK IS CO	NE	34	T018	R01E				4	4		
AIL510	NELSON S&G CO	WHITESIDE COUNTY-SAND	SW	29	T021	R07E				4	4		
AIL514	MIDWEST S&G	HENRY PIT, MARSHALL CO	NW	03	T013	R10E	DWU		X				
AIL516	BUILDERS S&G	CORDOVA, ROCK ISLAND CO	SE	33	T021	R02E	DWU	3i		4	4		
							DWU		X				
AIL518	WENDLING QUARRIES INC	THOMPSON	SE	02	T023	R03E	DWU		X				
AIL520	RIVERSTONE GROUP INC	CORDOVA (MC14@508),ROCK IS CO	S2	05	T020	R02E	DWU	3iB					
							DWU		X				
KS	**KANSAS**	**CRUSHED STONE**											
AKS002	BINGHAM S&G	BAXTER SPRINGS, CHEROKEE CO		22	T029	R23E				3	3		

NOTE 1: AASHTO 57 GRADATION MAXIMUM

RECENTLY ACTIVE AGGREGATE SOURCES

CODE	OPERATOR	SOURCE NAME	LOCATION				BULK SSD SpGr	DUR PCC CA	FA	FRICT HMA A	B	BEDS	TE
MN	**MINNESOTA**	**CRUSHED STONE**											
AMN002	HECTOR CONST CO	NEW ALBIN, HOUSTON CO	NW	09	T101	R04W		X		X	X		
AMN004	ROVERUD CONST INC	POOL HILL, HOUSTON CO	SW	33	T101	R04W		X		X	X		
AMN006	ROVERUD CONST INC	OTTERNESS, FILLMORE CO	E2	11	T101	R08W	2.75	3i		X	X	1 - 2	
AMN008	NEW ULM QUARTZITE QUARRY	QUARTZITE, BROWN CO	SW	35	T110	R31W				2	2		
AMN012	ROVERUD CONST INC	NEWBURG, FILLMORE CO	NE	08	T101	R08W		X		X	X		
AMN014	PEDERSEN BROS	BIG SPRINGS, FILLMORE CO	SW	09	T101	R10W					4	1 - 6	
AMN016	ROVERUD CONST INC	EITZEN, HOUSTON CO	SE	20	T101	R05W		X		X	X		
AMN018	ULLAND BROS	GRAND MEADOW, MOWER CO	NE	09	T103	R14W				X	X		
AMN020	ED BUNNE	LEROY, MOWER CO	NE	27	T101	R14W				X	X		
AMN022	ROVERUD CONST INC	UNDERPASS	NE	20	T101	R07W							
AMN024	MARTIN MARIETTA	YELLOW MEDICINE, YLW MED CO	SW	28	T116	R39W	DWU	3i		2	2	1	
AMN026	ORTONVILLE STONE CO	BIG STONE, BIG STONE CO		26	T121	R46W	DWU	3i		2	2		
AMN030	ROVERUD CONST INC	GENGLER, HOUSTON CO	SW	16	T102	R05W	DWU	3B		4	4	1 - 2	
AMN032	SIOUX ROCK PRODUCTS	COTTONWOOD, COTTONWOOD CO	SE	08	T107	R35W	DWU	3i		2	2		
AMN034	ROVERUD CONST INC	ENGRAV, HOUSTON CO	NE	24	T101	R08W							
AMN036	MILESTONE MATERIALS	GOLDBERG, OLMSTEAD CO	SW	36	T108	R14W				4	4		
AMN038	MILESTONE MATERIALS	RIFLE HILL, FILLMORE CO	NW	35	T102	R12W							
AMN042	DUININCK BROS INC	SCOTT, ROCK CO	NW	14	T104	R45W							
AMN044	MILESTONE MATERIALS	BIESANZ, WINONA CO	SW	19	T107	R07W	DWU	3i				1 - 2	
AMN046	MILESTONE MATERIALS	43 QUARRY, WINONA CO	NW	16	T106	R07W	DWU	3i				1 - 2	
		SAND & GRAVEL											
AMN504	BRUENING ROCK PROD INC	NEW ALBIN, HOUSTON CO		09	T101	R04W				4	4		
AMN506	HECTOR CONST CO	LUTTCHENS, HOUSTON CO	NW	23	T101	R04W	2.63	2B		4	4		
							2.68		X				
AMN508	SOUTHERN MN CONST CO INC	HANSON, JACKSON CO	NE	34	T101	R34W				4	4		
AMN510	WILLETT	WILLETT, JACKSON CO	SW	25	T102	R35W				4	4		
AMN512	MARTIN MARIETTA	MAUDLIN, NOBLES CO	SE	26	T101	R42W				4	4		
AMN516	ULLAND BROS	OLSON, FREEBORN CO	NW	31	T102	R20W	DWU		X				
AMN518	CARLSON MATERIALS CO	LANESBORO, FILLMORE CO	SE	07	T104	R10W	DWU		X				
AMN520	BUNNE & RANNELL	BUNNE & RANNELL, FILLMORE CO	SE	33	T101	R13W	DWU		X				
AMN522	AGGREGATE INDUSTRIES	PRAIRIE ISLAND #3, GOODHUE CO		23	T114	R15W	DWU	2					
AMN524	AGGREGATE INDUSTRIES	HASTING #2, DAKOTA CO		02	T114	R17W							
AMN526	NORTHWESTERN AGGR	LAKEVILLE, DAKOTA CO		01	T114	R20W							
AMN528	HANCOCK CONCRETE CO	POPE, POPE CO	NW	08	T125	R37W							
AMN532	ULLAND BROS	LARSON, FREEBORN CO		25	T102	R21W							
AMN534	ROVERUD CONST INC	SMERUD, HOUSTON CO	SW	35	T101	R03W	DWU		X				
AMN536	AGGREGATE INDUSTRIES	ELK RIVER, SHERBURNE CO		9,10	T033	R26W	DWU	2					
							DWU		X				
AMN538	ULLAND BROS	SHADE, MOWER CO	NW	04	T101	R18W	DWU		X				
AMN540	DUININCK BROS INC	SCOTT, ROCK CO		21	T104	R44W							
AMN542	RANDY KRAMER EXCAVATING	KIMBALL, STEARNS CO		34	T122	R29W							
AMN544	AGGREGATE INDUSTRIES	LAKEVILLE, DAKOTA CO		06	T114	R19W	DWU	2					

RECENTLY ACTIVE AGGREGATE SOURCES

CODE	OPERATOR	SOURCE NAME	LOCATION				BULK SSD SpGr	DUR PCC CA	FA	FRICT HMA A	B	BEDS	NOTE
MO	**MISSOURI**	**CRUSHED STONE**											
AMO002	L&W QUARRIES INC	KAHOKA, CLARK CO	NE	17	T065	R07W	DWU	2		4	4	2A - 3B	
										4	4	14 - 16	
AMO004	NORRIS AGGREGATES CO	MERCER, MERCER CO	SE	22	T066	R23W					5	3 - 5	
AMO006	GREENE LS CO	TURNER PROP, NODAWAY CO	SW	31	T067	R34W					5		
AMO012	NORRIS AGGREGATES CO	DR JEFFERIES, HARRISON CO	NW	03	T066	R26W				5	5	25C-25E	
AMO014	CARTER-WATERS CORP	EXPANDED SHALE, N. MARKET MO					DWU	2		3	3		
AMO018	NORRIS AGGREGATES CO	ROUTE C, DAVIESS CO	NE	30	T061	R28W				5	5	2 - 5	
AMO022	IRON MT TRAP ROCK CO	IRON MT, ST FRANCOIS CO								3	3		
AMO024	CENTRAL STONE CO	HUNTINGTON, RALLS CO	NE	17	T056	R06W	2.68	3i				6 - 9	
							2.68	3		4	4	6 - 11	
AMO026	MISSOURI PORTABLE STONE	WARRENTON, WARREN CO		15	T046	R02W				3	3		
AMO027	ST JOE LEAD	PEA RIDGE MINE, WASH. CO								3	3		
AMO028	PLATTIN MATERIALS CO	PLATTIN, ST GENEVIEVE CO		09	T039	R07W							
AMO030	KNOX COUNTY STONE CO	EDINA, KNOX CO	NE	25	T062	R12W				4	4	1 - 9	
AMO032	SCHILDBERG CONST CO INC	GRAHAM, NODAWAY CO	NW	36	T063	R37W				4	4	2 - 3	
AMO038	CENTRAL STONE CO	GREENSBURG, SCOTLAND CO		22	T064	R12W							
AMO040	S&A CONSTRUCTION	SO ALLENDALE, WORTH CO	NW SW	17	T065	R30W							
AMO042	TRAGER	GALLATIN, DAVIESS CO		13	T058	R28W							
AMO044	CENTRAL STONE CO	NEW LONDON, RALLS CO	NE	24	T056	R05W							
AMO046	NORRIS AGGREGATES CO	BETHANY, HARRISON CO	SW	01	T063	R28W				5	5		
		SAND & GRAVEL											
AMO502	IDEAL SAND CO	WAYLAND, CLARK CO	SW	21	T065	R06W				4	4		
							2.66		X				
AMO504	MEDUSA AGGREGATES	ALBANY, GENTRY CO		27	T063	R31W				4	4		
MO506	MILBURN CO	GALLITIN, DAVIESS CO	CT	16	T059	R27W				4	4		
MO510	TURNER QUARRIES	CLEARMONT, NODAWAY CO	SW	34	T066	R37W				4	4		
AMO516	STONER SAND CO	MT MORIAH, HARRISON CO		12	T064	R26W	2.65		X				
AMO518	CENTRAL STONE CO	TAYLOR, MARION CO	NW	01	T059	R06W							

RECENTLY ACTIVE AGGREGATE SOURCES

CODE	OPERATOR	SOURCE NAME	LOCATION				BULK SSD SpGr	DUR PCC CA	FA	FRICT HMA A	B	BEDS	N E
NE	**NEBRASKA**	**CRUSHED STONE**											
ANE002	MARTIN MARIETTA	WEEPING WATER MINE, CASS CO		03	TO10	R11E	2.69	3iB		5	5	10A- 10B	
							DWU	3iB		5	5	9-10A&B	1
							DWU	2		5	5	9-10A&B	2
ANE010	FORT CALHOUN STONE CO	FT CALHOUN, WASHINGTON CO	SE	01	TO17	R12E				5	5	25C- 25E	
											5	25A- 25C	
											5	25F	
											5	26A- 26E	
											5	27A- 27B	
ANE012	MARTIN MARIETTA	SPRINGFIELD, SARPY CO		28	TO13	R12E							
		SAND & GRAVEL											
ANE538	STALP S&G	WEST POINT, CUMING CO	SE	28	TO22	R06E	2.64		X				
		CLASS V AGGREGATE FOR CONCRETE											
ANE502	LYMAN-RICHEY S&G	CULLOM #5, CASS CO	SW	31	TO13	R12E	2.62	3		4	4		
							2.62		X				
ANE504	LYMAN-RICHEY S&G	WATERLOO #40, DOUGLAS CO	SE	19	TO15	R10E	2.62	3		4	4		
							2.62		X				
ANE514	LYMAN-RICHEY S&G	OREAPOLIS #8, CASS CO	SE	36	TO13	R13E	2.62	3		4	4		
							2.62		X				
ANE526	WESTERN S&G	FREMONT, DODGE CO	NW	36	TO17	R08E	2.62	3		4	4		
							2.62		X				
ANE530	WESTERN S&G	SOUTH BEND, CASS CO	SW	13	TO12	R10E	2.62	3		4	4		
							2.62		X				
ANE532	WESTERN S&G	ABEL SPUR, SAUNDERS CO	SW	30	TO13	R09E	2.62	3		4	4		
							2.62		X				
ANE534	MALLARD S&G	SPRINGFIELD #3, SARPY CO		32	TO13	R12E	2.62	3		4	4		
							2.62		X				
ANE536	MARTIN MARIETTA	GRETNA, SARPY CO		17	TO13	R10E	2.62	3		4	4		
							2.62		X				
ANE542	LYMAN-RICHEY S&G	PLANT #47, DODGE CO	NW	07	TO17	R09E	2.62	3		4	4		
							2.62		X				
ANE544	MALLARD S&G	VALLEY, DOUGLAS CO	NE	06	TO15	R10E	2.62	3		4	4		
							2.62		X				
ANE546	LYMAN-RICHEY S&G	PLANT #77, HALL CO	NE SW	27	TO11	R09W	2.62		X				

NOTE 1: IF BED 9 IS INCORPORATED WITH BEDS 10A&B, THE DURABILITY CLASS BECOMES A CLASS 3iB IF THE COARSE AGGREGATE DOES NOT EXCEED 45% OF THE TOTAL AGGREGATE IN THE CONCRETE MIX.

NOTE 2: BED 9 CAN'T BE USED BY ITSELF IN PC CONCRETE. IF BED 9 IS INCORPORATED WITH BEDS 10A&B, THE DURABILITY BECOMES A CLASS 2.

RECENTLY ACTIVE AGGREGATE SOURCES

CODE	OPERATOR	SOURCE NAME	LOCATION	BULK SSD SpGr	DUR PCC CA	FA	FRICT HMA A	B	BEDS	NOTE
SD	**SOUTH DAKOTA**	**CRUSHED STONE**								
ASD002	EVERIST INC	DELL RAPIDS E. MINNEHAHA CO	SW 10 T104 R49W	2.64	3iB		2	2		
ASD004	CONCRETE MATLS CO	SIOUX FALLS QUARTZITE	13 T101 R50W	2.64	3iB		2	2	1	
ASD006	MYRL & ROY'S PAVING INC	EAST SIOUX, MINNEHAHA CO	SE 27 T101 R48W	DWU	3i		2	2	1	
ASD008	SPENCER QUARRIES INC	SPENCER, HANSON CO	24 T103 R57W				2	2		
ASD010	EVERIST INC	DELL RAPIDS W. MINNEHAHA CO	NW 16 T104 R49W	2.64	3iB		2	2		
		SAND & GRAVEL								
ASD502	BOYER SAND AND GRAVEL	BOYER, UNION CO	10 TO95 R48W	DWU	2		4	4		
ASD504	MIDWEST PAVING CO	HAWARDEN, UNION CO	SW 15 TO95 R48W				4	4		
ASD506	MIDWEST PAVING CO	RICHLAND, UNION CO	SW 20 TO92 R49W				4	4		
ASD508	CONCRETE MATERIALS CO	CANTON, LINCOLN CO	17 TO89 R48W				4	4		
				2.68		X				
ASD510	CONCRETE MATERIALS CO	MINNEHAHA CO	02 T101 R49W							
ASD514	HIGMAN S&G	HUDSON, UNION CO	02 TO95 R48W	DWU	2		4	4		
ASD516	HIGMAN S&G	VOLIN, CLAY CO	12 TO94 R54W							
ASD518	MYRL & ROY'S PAVING INC	MCVAY, LINCOLN CO	SE 17 TO98 R45W							
ASD520	BOYER SAND AND GRAVEL	BOYER NORTH, UNION CO	NE 01 TO95 R48W							
ASD522	EVERIST INC	BROOKINGS, BROOKINGS CO	S2 31 T110 R49W	DWU		X				
ASD524	HIGMAN S&G	SPINK, UNION CO	05 TO93 R50W							
ASD526	CONCRETE MATERIALS CO	CORSON, MINNEHAHA CO	23,24T102 R48W	DWU	2					
WI	**WISCONSIN**	**CRUSHED STONE**								
AWI002	BRYAN DRESSER TRAP ROCK	DRESSER-TRAPROCK					3	3		
AWI004	MARTIN MARIETTA	CNWRR-ROCK SPRINGS					2	2		
WI006	KIELER KOWALSKI	TENNYSON, GRANT CO		DWU	3i		4	4		
AWI008	QUALITY STONE INC	WETZEL, CRAWFORD CO	NE 31 TO07 R06W	DWU	3i		4	4	7	
AWI010	ED KRAEMER & SONS INC	RICHARDS, GRANT CO	SW 21 TO01 R02W	DWU	3i		4	4		
AWI012	SCARPELLI MATERIALS	WATERLOO QTZ, DODGE CO	27,28,33, 34 TO08 R13E				2	2		
AWI018	RIVER CITY STONE INC	FREESE, GRANT CO	NW 28 TO01 R02W							
AWI020	MILESTONE MATERIALS	MEDARY, LA CROSSE CO	NW 27 TO16 R07W				4	4		
AWI022	MILESTONE MATERIALS	KINGS BLUFF, LA CROSSE CO	NE 25 TO18 R08W	DWU	3		4	4	1 - 4	
				DWU	2				1 - 5	1
AWI030	HAVERLAND STONE CO	HAVERLAND, GRANT CO	NW 26 TO02 R02W							
AWI034	ED KRAEMER & SONS INC	HOUSEHOLDER, RICHLAND CO								
AWI036	MILESTONE MATERIALS	TORK, WOOD CO.								
AWI038	ROCKY MTN ENTERPRISES	ATHEN, MARATHON CO	SE 24 TO30 R04E		3i		2	2		
AWI040	MILESTONE MATERIALS	JACKSON COUNTY IRON MINE	22 TO21 R03W				2	2		
AWI042	BOON CONSTRUCTION CO	CROSBY	NW SW 13 TO23 R03W				2	2		
AWI044	MILESTONE MATERIALS	SLAMA, CRAWFORD CO	17,18TO07 R06W	DWU	3i		4	4	3 - 8	
		SAND & GRAVEL								
AWI502	PRAIRIE S&G CO	PRAIRIE DU CHIEN, CRAWFORD CO	24 TO07 R07W	2.67	3i		4	4		
				2.67		X				
AWI504	DUBUQUE S&G CO	VOGT FARM, GRANT CO	17 TO90 R03E	2.67	3i		3	3		
				2.67		X				
AWI506	PRAIRIE S&G CO	KRAMER, CRAWFORD CO	NE 12 TO07 R07W	DWU	X		3	3		
				2.68		X				
AWI508	PRAIRIE S&G CO	BARN	SE 12 TO07 R07W	2.68	X					
				2.69		X				
AWI510	RIVER CITY STONE INC	KRUG, GRANT CO	SW 17 TO01 R02W	DWU		X				
AWI512	MILESTONE MATERIALS	GIBBS	NE 25 TO25 R09W							
AWI514	HOLST EXCAVATING	REDWING #7	NE 33 TO25 R18W							
AWI516	MILESTONE MATERIALS	SCHEER, TREMPEALAU CO	19 TO18 R08W	DWU		X				

NOTE 1: BED 1- TOP 16' OF BED 5

REVETMENT STONE
SOURCE APPROVAL

CODE	OPERATOR	SOURCE NAME	LOCATION				BEDS	REVETMENT CLASS
DISTRICT 1								
A40006	MARTIN MARIETTA	GRAND GEORGE	SW	18	TO89	R25W	3-5	D
A42002	MARTIN MARIETTA	ALDEN	NW	20	TO89	R21W	3	A, B, D, E
A42004	GEHRKE QUARRIES INC	GIFFORD	NW	04	TO86	R19W	9-10	A, B, E
A50002	MARTIN MARIETTA	SULLY	SE	16	TO79	R17W	36-41	D, E
							42-47	D, E
A64002	MARTIN MARIETTA	FERGUSON	SW	05	TO82	R17W	8-17	E
							1-7	D, E
A85006	MARTIN MARIETTA	AMES MINE	SW	24	TO84	R24W	26	E
							30-35	E
							47	A, B, D, E
A86002	WENDLING QUARRIES INC	MONTOUR	NW	09	TO83	R06W	8-12	D, E
A94002	MARTIN MARIETTA	FORT DODGE MINE	SW	24	TO89	R29W	36-42	A, B, D, E
DISTRICT 2								
A03002	BRUENING ROCK PROD INC	WEXFORD	NE	36	TO98	R03W	1B-8	A, B, D, E
A03028	ROVERUD CONST CO	WELPER-JOHNSON	SW	35	TO99	R04W	FULL FACE	A, B, D, E
A03040	BRUENING ROCK PROD INC	DEE	SE	21	TO99	R04W	5A-5D	A, B, D, E
A03050	BRUENING ROCK PROD INC	GREEN	NW	16	TO96	R06W	1-3	A, B, D, E
A03066	WILTGEN CONST CO	ELSBERN	NW	29	TO97	R06W	2	A, B, D, E
A07004	BMC AGGREGATES LC	WATERLOO SOUTH	NW	18	TO87	R12W	1-23	A, B, D, E
							17-23	A, B, D, E
A07014	NIEMANN CONST CO	GLORY	NE	36	TO87	R11W	1-TOP 5' OF BED 4	D
A07018	BMC AGGREGATES LC	RAYMOND-PESKE	SW	01	TO88	R12W	1B-5	A, B, D, E
							1B-10	A, B, D, E
							6-10	A, B, D, E
A09004	NIEMANN CONST CO	DENVER-FOELSKE	NE	29	TO91	R13W	BOTTOM 8' BED 12-TOP 9' BED 13	A, B, D, E
A09006	NIEMANN CONST CO	TRIPOLI-PLATTE	SW	36	TO93	R13W	1-4	A, B, D, E
A12004	GREENE LIMESTONE CO	LUBBEN	NW	25	TO93	R17W	1-20	D
A12014	NIEMANN CONST CO	OLTMANN	SE	08	TO91	R16W	1-TOP ½ BED 10	D
A12020	GREENE LIMESTONE CO	BRUNS #2	NW	21	TO91	R18W	1-5	D
A17008	MARTIN MARIETTA	PORTLAND WEST		19	TO96	R19W	1-8	A, B, D, E
A17020	MARTIN MARIETTA	MASON CITY	NE	29	TO97	R20W	1-6, 7-9	A, B, D, E
A19002	GREENE LIMESTONE CO	TRACY	SE	29	TO94	R11W	9-10	A, B, D, E
A22002	KUHLMAN CONST CO	TWIN ROCK-SCHRADER	NW	14	TO94	R05W	3-11	A, B, D, E
A22004	ROVERUD CONST CO	BENTE/ELKADER/WATSON	SW	12	TO93	R05W	5-9	A, B, D, E
A22008	KUHLMAN CONST CO	ANDEREGG	SE	32	TO92	R02W	2-8	A, B, D, E
A22010	KUHLMAN CONST CO	OSTERDOCK	SE	02	TO91	R03W	3-8	A, B, D, E
A22012	KUHLMAN CONST CO	SCHMIDT	NE	33	TO91	R01W	2-6	A, B, D, E
A22014	ROVERUD CONST CO	BLUME	NE	09	TO93	R03W	1-12	A, B, D, E
A22016	KUHLMAN CONST CO	GISLESON	NW	06	TO95	R04W	1-15	A, B, D, E
A22020	KUHLMAN CONST CO	MUELLER	NE	30	TO94	R03W	1-8	A, B, D, E
A22026	KUHLMAN CONST CO	DOERRING-LUANA	SE	05	TO95	R05W	3-5	A, B, D, E
A22030	KUHLMAN CONST CO	EBERHARDT	NW	27	TO93	R05W	1-6	A, B, D, E
A22034	KUHLMAN CONST CO	KRUSE	NW	17	TO92	R04W	5-12	A, B, D, E
A22038	KUHLMAN CONST CO	FASSBINDER	SW	09	TO92	R03W	2-6	A, B, D, E
A22040	KUHLMAN CONST CO	HARTMAN	NW	29	TO91	R06W	1-4	A, B, D, E
A22042	ROVERUD CONST CO	MORAREND	CT	35	TO92	R03W	1-9	A, B, D, E
A22046	KUHLMAN CONST CO	JOY SPRINGS-BURRACK	NW	19	TO91	R06W	1-2	A, B, D, E
A22048	ROVERUD CONST CO	TUCKER	SW	18	TO91	R05W	1-3	D
A22060	ROVERUD CONST CO	JOHNSON	NW	26	TO93	R04W	2-5	A, B, D, E
A22062	ROVERUD CONST CO	SNY MAGILL	SE	22	TO94	R03W	6-10	A, B, D, E
A22070	ROVERUD CONST CO	BERNHARD/GIARD	NW	35	TO95	R04W	1-3	A, B, D, E
A22074	RIVER CITY STONE CO	STRAWBERRY POINT	NE	19	TO91	R06W	1-2	A, B, D, E
A22082	NIEMANN CONST CO	REIERSON	NW	20	TO94	R06W	1	D

REVETMENT STONE
SOURCE APPROVAL

DISTRICT 2 (Continued)

CODE	OPERATOR	SOURCE NAME	LOCATION				BEDS	REVETMENT CLASS
A22084	CJ MOYNA & SONS	MOYNA		14	TO93	R05W	6-9	A, B, D, E
A33002	NIEMANN CONST CO	ELDORADO-JACOBSON	SW	17	TO95	R08W	4-6B	A, B, D, E
A33004	NIEMANN CONST CO	HOUG	SW	11	TO94	R08W	3-8	A, B, D, E
A33006	NIEMANN CONST CO	MARYVILLE	S2	24	TO91	R07W	1-2	A, B, D, E
A33010	WILTGEN CONST CO	VOSHELL	NW	21	TO93	R07W	1-4	A, B, D, E
A33016	NIEMANN CONST CO	MAYNARD	NE	23	TO92	R09W	FULL FACE	D
A33018	NIEMANN CONST CO	FAIRBANK	SW	28	TO91	R10W	1-5C	D
							5A-5C	A, B, D, E
A33020	NIEMANN CONST CO	YEAROUS	SW	19	TO93	R08W	1-10C	D
A33022	NIEMANN CONST CO	MILLER	SW	35	TO95	R10W	1-6	D
A33024	NIEMANN CONST CO	WAUCOMA	NW	25	TO95	R10W	1-TOP 4' BED 5	A, B, D, E
A33026	WILTGEN CONST CO	LYNCH	NW	05	TO95	R10W	6-8	A, B, D, E
A33030	NIEMANN CONST CO	SCHWAMMAN-ST LUCAS	NE	29	TO95	R09W	FULL FACE	A, B, D, E
A33032	BRUENING ROCK PROD INC	LANDIS	SE	12	TO93	R08W	1-5	A, B, D, E
A33034	NIEMANN CONST CO	MCDONOUGH	SE	36	TO94	R08W	1-3	D
A33036	NIEMANN CONST CO	GRAHAM-HAWKEYE	SW	06	TO94	R09W	1-4	A, B, D, E
A33038	NIEMANN CONST CO	PAPE	NE	28	TO95	R08W	1-3	A, B, D, E
							3-5	A, B, D, E
A34004	GREENE LIMESTONE CO	MAXON	SE	07	TO94	R17W	4C-19	A, B, D, E
A34006	GREENE LIMESTONE CO	JOHLAS	SW	07	TO94	R15W	1-7	D
A34008	GREENE LIMESTONE CO	WARNHOLTZ	SW	09	TO96	R16W	5-16	D
							17-18	A, B, D, E
A35002	MARTIN MARIETTA	DOWS	NE	30	TO91	R22W	1-12	A, B, D, E
							1-13	D
A35006	MARTIN MARIETTA	HIBNESS	SE	22	TO91	R20W	1-12A	A, B, D, E
A41002	BMC AGGREGATES LC	GARNER NORTH	SE	11	TO95	R24W	6	A, B, D, E
A41004	BMC AGGREGATES LC	GARNER SOUTH-WIELAND	NW	13	TO95	R24W	6	A, B, D, E
A45002	ROVERUD CONST CO	ECKERMAN	NW	33	T100	R11W	7-9	A, B, D, E
A45006	BRUENING ROCK PROD INC	NELSON	NE	33	TO99	R13W	8-9	A, B, D, E
A45008	BRUENING ROCK PROD INC	DOTZLER	NE	23	TO99	R12W	7-10A	A, B, D, E
A45010	BRUENING ROCK PROD INC	DALEY	NE	11	TO98	R11W	9-10	A, B, D, E
A46006	MARTIN MARIETTA	HODGES	NE	32	TO92	R28W	4-18	D
A46014	MARTIN MARIETTA	PEDERSEN	SW	28	TO92	R28W	4-13, 4-20	D
A66002	FALK CONST CO	DUENOW	SE	08	TO99	R17W	6-8	A, B, D, E
A76002	MARTIN MARIETTA	GILMORE CITY	NE	36	TO92	R31W	1A-3	A, B, D, E
A76004	MARTIN MARIETTA	MOORE	SW	25	TO92	R31W	1A-3	A, B, D, E
A96002	ROVERUD CONST CO	KENDALLVILLE	NE	33	T100	R10W	2-9	A, B, D, E
A96004	ROVERUD CONST CO	HOVEY	SW	28	TO98	R08W	2-6	A, B, D, E
A96014	NIEMANN CONST CO	FESTINA	SW	26	TO96	R09W	1-3	A, B, D, E
A96017	BRUENING ROCK PROD INC	SKYLINE B	CT	10	TO98	R08W	4-11	A, B, D, E
A96048	NIEMANN CONST CO	LOVE #1	NW	30	TO96	R10W	1-10	D
A96049	NIEMANN CONST CO	LOVE #2	NW	30	TO96	R10W	1-10	D
A96052	ROVERUD CONST CO	ESTREM	SW	04	TO97	R07W	2-8	A, B, D, E
A96060	ROVERUD CONST CO	BURR OAK	SE	23	T100	R09W	3-5	A, B, D, E
A96064	ROVERUD CONST CO	STIKA	NW	15	TO97	R10W	5A-8B	A, B, D, E
A98002	MARTIN MARIETTA	HARRIS	SW	29	T100	R20W	6-11	A, B, D, E
A98016	ULLAND BROS	EMIL OLSON-BOLTON	SW	10	TO99	R20W	2-5B	A, B, D, E
A98010	BMC AGGREGATES LC	FERTILE	SW	36	TO98	R22W	15-20	A, B, D, E
A99002	KNIFE RIVER	VOSS		36	TO90	R26W	8	A, B, D, E
AMN004	ROVERUD CONST CO	POOL HILL, HOUSTON CO	SW	33	T101	R04W	1-8	A, B, D, E
AMN030	ROVERUD CONST CO	GENGLER, HOUSTON CO	SW	16	T102	R05W	1-4	A, B, D, E
AMN034	ROVERUD CONST CO	ENGRAV, HOUSTON CO	NW	24	T101	R08W	1A-2B	A, B, D, E

REVETMENT STONE
SOURCE APPROVAL

DISTRICT 3

CODE	OPERATOR	SOURCE NAME	LOCATION				BEDS	REVETMENT CLASS
AMN024	MARTIN MARIETTA	YELLOW MEDICINE, YELLOW MED	SW	28	T116	R39W	GRANITE	A, B, D, E
AMN032	SIOUX ROCK PRODUCTS	COTTONWOOD, COTTONWOOD CO	SE	08	T107	R35W	ENTIRE LEDGE*	A, B, D, E
ASD002	EVERIST INC	DELL RAPIDS, MINNEHAHA CO	SW	10	T104	R49W	ENTIRE LEDGE*	A, B, D, E
ASD004	CONCRETE MATERIALS CO	SIOUX FALLS QUARTZITE		13	T101	R50W	ENTIRE LEDGE*	A, B, D, E
ASD006	MYRL & ROY'S PAVING INC	EAST SIOUX, MINNEHAHA CO	SE	27	T101	R48W	ENTIRE LEDGE*	A, B, D, E
ASD008	SPENCER QUARRIES INC	SPENCER, HANSON CO		24	T103	R57W	ENTIRE LEDGE*	A, B, D, E

*ISOLATED POCKETS OF SANDSTONE MAY BE CAUSE TO REJECT ALL OR PORTIONS OF A SHOT; ALSO, THE PIPESTONE DEPOSITS WILL DEFINE THE LOWER LIMITS OF LEDGE. IN BOTH INSTANCES A VISUAL EXAMINATION WILL REVEAL THE PRESENCE OF EITHER UNCONSOLIDATED SANDSTONE OR PIPESTONE MATERIAL.

DISTRICT 4

A01002	SCHILDBERG CONST CO INC	MENLO	SE	17	TO77	R31W	15A-15C	B, D, E
A01006	SCHILDBERG CONST CO INC	HOWE	SW	01	TO76	R31W	25B-25E	D
A01008	SCHILDBERG CONST CO INC	JEFFERSON	NE	17	TO77	R31W	25B-25E	D
A02002	SCHILDBERG CONST CO INC	MT ETNA	SW	23	TO73	R34W	11-13	D
A02004	SCHILDBERG CONST CO INC	CORNING		10	TO71	R34W	3-5	D
A15008	SCHILDBERG CONST CO INC	ATLANTIC MINE	NE	13	TO76	R37W	25B-25E	D
A36002	SCHILDBERG CONST CO INC	THURMAN	NW	23	TO70	R43W	18	D
A43002	SCHLDBERG CONST CO INC	LOGAN		19	TO79	R42W	25B-25E & 3' OF 26	B, D, E
A43004	WESTERN IA LIMESTONE	LOGAN		17	TO79	R42W	25B-25E & 3' OF 26	B, D, E
A61002	SCHILDBERG CONST CO INC	EARLY CHAPEL-DAGGETT	NW	10	TO76	R29W	14B	B, D, E
A61024	MARTIN MARIETTA	PENN-DIXIE	SW	32	TO76	R27W	TOP 4' OF BED 20A	D, E
A61026	MARTIN MARIETTA	MASON	SW	16	TO77	R28W	TOP 4' OF BED 20A	D, E
A69002	SCHILDBERG CONST CO INC	STENNETT	NE	27	TO73	R38W	KERFORD	D
A73004	SCHILDBERG CONST CO INC	SHAMBAUGH	SW	20	TO67	R36W	4-6	D
A78002	SCHILDBERG CONST CO INC	CRESCENT		35	TO76	R24W	25B-25E	D, E
A78006	SCHILDBERG CONST CO INC	MACEDONIA	NE	28	TO74	R40W	16	D
A87004	SCHILDBERG CONST CO INC	102 QUARRY	NE	32	TO68	R34W	1	D
A88002	SCHILDBERG CONST CO INC	THAYER	NE	35	TO72	R28W	20B	D
							25B-25E	B, E
AMO040	S&A CONSTRUCTION	SOUTH ALLENDALE, WORTH CO	SW	17	TO65	R30W	CAPTAIN CREEK	B, D, E
ANE002	MARTIN MARIETTA	WEEPING WATER, CASS CO		03	TO10	R11E	10A-10B	E
							9-10B	E
ANE004	KERFORD LIMESTONE	WEEPING WATER, CASS CO	SE	32	TO11	R11E	10A-10B	D, E
ANE010	FORT CALHOUN STONE	FORT CALHOUN, WASHINGTON CO	SE	01	TO17	R12E	25B-25E	D, E

REVETMENT STONE
SOURCE APPROVAL

DISTRICT 5

CODE	OPERATOR	SOURCE NAME	LOCATION					BEDS	REVETMENT CLASS
A04004	L&W QUARRIES	MARTIN #3		E2	20	TO70	R19W	1-3	D
								6	D, E
A04016	L&W QUARRIES	LEMLEY EAST #5		CT	35	TO70	R19W	1-3	D
								6	D, E
A04018	L&W QUARRIES	CLARKDALE #8		SE	15	TO69	R18W	1A	D, E
								1C	D, E
								4	D
A20002	MARTIN MARIETTA	OSCEOLA		NW	12	TO72	R26W	1-10	D
								20A	D
A26004	DOUDS STONE INC	LEWIS		W2	02	TO69	R12W	3-5	D
								6-7	D, E
								3-7	D, E
A26006	DOUDS STONE INC	BROWN	SW	NW	02	TO69	R12W	1	D, E
A27002	MARTIN MARIETTA	GRAND RIVER		NW	22	TO70	R27W	17	D
A27008	MARTIN MARIETTA	DECATUR		SE	32	TO69	R27W	7	D
								13-14	D
A29002	L&W QUARRIES	MEDIAPOLIS		SE	01	TO71	R04W	3-7	D, E
								15-18	D, E
A29008	CESSFORD CONST CO	NELSON		NE	26	TO72	R02W	7-14	D, E
								7-20	D, E
								15-20	D
								15-24	D
								21-24	D, E
								25-27	D
A29012	CESSFORD CONST CO	GEODE		NE	01	TO69	R05W	1-5	D, E
								9-13	D, E
								REEF	E
A44008	DOUDS STONE INC	NELSON-TWEEDY		SE	36	TO71	R06W	9-14	D, E
								13-14	D, E
A51006	WINN CORP	JEFFERSON		NE	09	TO71	R10W	5-8	D, E
								LOWER 4' OF BED 8	D, E
								10-12	D, E
A54002	DOUDS STONE INC	KESWICK		NW	21	TO77	R12W	13-15	D, E
								13-17	D
A54004	DOUDS STONE INC	OLLIE		SW	01	TO74	R11W	9-12	D, E
								9-13	D
								9-18	D, E
								13-18	D, E
								19-26	D
								27-29	D, E
								30-33	D
A54008	DOUDS STONE INC	HARPER		SE	11	TO76	R11W	13-22	D, E
								32-37	D, E
								38-40	D, E
A54010	DOUDS STONE INC	LYLE		NW	13	TO74	R13W	36-38	D, E
								40	D, E
A56002	CESSFORD CONST CO	HAWKEYE		NE	10	TO68	R06W	1-21	D
								22-27	D, E
A56008	CESSFORD CONST CO	DONNELLSON		SE	05	TO67	R06W	10-13	D, E
A62008	MARTIN MARIETTA	GIVEN #2		SE	14	TO74	R16W	2-6	D
A63002	MARTIN MARIETTA	DURHAM MINE		NE	08	TO75	R18W	88-95	D, E
								95-96	D, E
[illegible]63010	BRUENING ROCK PROD INC	S&S		SE	25	TO75	R20W	25	D, E
A89002	DOUDS STONE INC	DOUDS MINE		SE	25	TO70	R11W	5-13	D, E

REVETMENT STONE
SOURCE APPROVAL

CODE	OPERATOR	SOURCE NAME	LOCATION				BEDS	REVETMENT CLASS
DISTRICT 5 (Continued)								
A89006	CESSFORD CONST CO	FARMINGTON-COMANCHE	NE	05	TO67	R08W	5-12	D
							14-15	D
							16-17	D, E
							18-23	D
A89008	DOUDS STONE INC	SELMA-GARDNER	NW	16	TO70	R11W	14-21	D, E
							14-31	D, E
							22-31	D, E
A92002	DOUDS STONE INC	WESTCHESTER	NE	19	TO76	R08W	15-16	D, E
A92008	RIVER PRODUCTS CO	PEPPER-KEOTA FIELD	SW	31	TO76	R09W	2-20	D
							22-28	D
							29-36	D
AIL014	CESSFORD CONST CO	DALLAS CITY, HENDERSON CO	SW	36	TO08	R07W	5-6	D, E
AIL020	GRAY QUARRY INC	GRAY, HANCOCK CO	NE	31	TO05	R08W	2	D, E
AMO002	L&W QUARRIES	KAHOKA, CLARK CO	NE	17	TO65	R07W	2A-3B	D, E
AMO012	NORRIS AGGREGATES CO	JEFFERIES, HARRISON CO	NW	03	TO66	R26W	25C-25D	D, E
AMO024	CENTRAL STONE	HUNTINGTON, RALLS CO	NE	17	TO56	R06W	6-11	D, E
DISTRICT 6								
A06006	WENDLING QUARRIES INC	GARRISON B	NE	33	TO85	R11W	6-23	A, B, D, E
							6-36	EROSION
A06012	COOTS MATERIALS CO INC	JABENS	SW	07	TO85	R11W	6-11, 12	A, B, D, E
A06014	WENDLING QUARRIES INC	VINTON-MILROY	S2	10	TO85	R10W	1-7	D
A06016	COOTS MATERIALS CO INC	COOTS	SW	36	TO86	R11W	2A ON DOWN	D
A10002	NIEMANN CONST CO	LAMONT-WESTON	NW	14	TO90	R07W	1-6	A, B, D, E
A10004	NIEMANN CONST CO	JESUP-BLOOM	SW	32	TO89	R10W	2-5	A, B, E
							2-8	D
A10008	BRUENING ROCK PROD INC	OELWEIN-MISHLER	NW	02	TO90	R09W	4-5	A, B, D, E
A10010	NIEMANN CONST CO	HAZELTON	NW	11	TO90	R09W	4A-4D	A, B, D, E
A10016	NIEMANN CONST CO	OELWEIN #2	SE	03	TO90	R09W	13-17	A, B, D, E
A10022	BRUENING ROCK PROD INC	BROOKS	NW	02	TO88	R09W	4-5	EROSION
A10024	NIEMANN CONST CO	RASMUSSEN #2	SE	21	TO88	R08W	1-6 + QUARRY FLR	D
A10030	NIEMANN CONST CO	AURORA-SOUTH	NW	19	TO90	R07W	1-3	A, B, D, E
A16004	WENDLING QUARRIES INC	LOWDEN-SCHNECKLOTH	NW	04	TO81	R01W	1	A, B, D, E
A16006	WENDLING QUARRIES INC	STONEMILL	SE	14	TO80	R03W	4A-4D	A, B, D, E
A16010	WENDLING QUARRIES INC	PEDEN	NE	10	TO79	R03W	1-3	D, EROSION
A16012	WEBER STONE CO	ONION GROVE	SE	14	TO82	R02W	1-7	A, B, D, E
A16014	WENDLING QUARRIES INC	TOWNSEND	NW	02	TO79	R02W	2-10	A, B, D, E
A16022	WENDLING QUARRIES INC	TRICON	N2	09	TO82	R04W	1	A, B, D, E
A23002	WENDLING QUARRIES INC	BLOORE-ELWOOD	NW	08	TO83	R02E	1-2	A, B, D, E
A23004	WENDLING QUARRIES INC	BEHR	SW	02	TO81	R03E	1-2	A, B, D, E
A23006	WENDLING QUARRIES INC	SHAFFTON	NE	11	TO80	R05E	16-20	A, B, D, E
							3-14	D, EROSION
A23010	WENDLING QUARRIES INC	GOOSE LAKE	SW	22	TO83	R05E	2-4	E
A23012	WENDLING QUARRIES INC	TEEDS GROVE	SW	03	TO83	R06E	2-4	A, B, D, E
A23016	WENDLING QUARRIES INC	LYONS	NW	18	TO82	R07E	UPPER OR LOWER LEDGE	E
A28008	KUHLMAN CONST	EDGEWOOD WEST	CT	04	TO90	R05W	2-7	A, B, D, E
A28010	KUHLMAN CONST	TIBBOTT	SW	23	TO90	R04W	1-5	A, B, D, E
A28014	KUHLMAN CONST	LOGAN	SW	10	TO88	R05W	2-8	A, B, D, E
A28016	KUHLMAN CONST	WHITE	NW	02	TO88	R04W	1-2	A, B, D, E
A28020	BARD CONCRETE	DEUTMEYER	SW	13	TO88	R03W	1-6	A, B, D
A28030	KUHLMAN CONST	GRIEF	NE	18	TO87	R03W	1-2	A, B, D, E

REVETMENT STONE
SOURCE APPROVAL

DISTRICT 6 (Continued)

CODE	OPERATOR	SOURCE NAME	LOCATION				BEDS	REVETMENT CLASS
A28038	KUHLMAN CONST	EDGEWOOD EAST	NW	06	TO90	R04W	1B-5	A, B, D, E
							2-6	E
A28040	BARD CONCRETE	KRAPFL	SE	23	TO89	R03W	1-5	A, B, D
							4	E
A28052	RIVER CITY STONE CO	MANCHESTER	SW	09	TO88	R05W	6-8	A, B, E
			TOP LEDGES – NORTH					D
A28056	RIVER CITY STONE CO	THORPE	NW	33	TO90	R05W	FULL FACE	A, B, D, E
A28058	RIVER CITY STONE CO	ROSSOW/MANCHESTER	NW	16	TO88	R05W	2-8	A, B, D, E
A31002	RIVER CITY STONE CO	ROSE SPUR		27	TO90	R02E	1-8	A, B, D, E
A31006	KUHLMAN CONST	DYERSVILLE	SE	32	TO89	R02W	4-12	A, B, D, E
A31008	RIVER CITY STONE CO	KLEIN-RICHARDSVILLE	NW	33	TO90	R01E	2-4B	A, B, D
							3A-4B	E
A31010	RIVER CITY STONE CO	BROWN	NW	33	TO89	R02E	FULL FACE	D
							3-9	A, B, E
A31014	BARD CONCRETE	KURT	N2	35	TO87	R02W	1-2	A, B, D, E
A31018	RIVER CITY STONE CO	MELOY	NW	23	TO87	R01E	FULL FACE	A, B, D
							1-3	E
A31020	RIVER CITY STONE CO	SCHLITCHE	SE	11	TO89	R02W	1-4	A, B, D, E
A31026	WENDLING QUARRIES INC	ARNSDORF	SE	25	TO87	R02E	1-2	A, B, D, E
A31028	RIVER CITY STONE CO	THOLE	NW	21	TO87	R02E	2-3	A, B
							3	D, E
A31034	RIVER CITY STONE CO	HERMSEN	NE	33	TO90	R02W	1-2	A, B, D, E
A31036	RIVER CITY STONE CO	BALLTOWN	SE	05	TO90	R01E	1-7	A, B, D, E
1040	RIVER CITY STONE CO	KENNEDY	NW	03	TO88	R01W	FULL FACE	A, B, D, E
1044	RIVER CITY STONE CO	GASSMAN	SE	07	TO88	R03E	2-9	A
							2-10	B, D
							5-9	E
A31050	RIVER CITY STONE CO	PLOESSEL-DYERSVILLE	N2	07	TO88	R02W	2-5	A, B, D
							3-5	E
A31052	WEBER STONE CO	EPWORTH-KIDDER	SW	02	TO88	R01W	FULL FACE	A, B, D, E
A31056	RIVER CITY STONE CO	RUBIE	SE	06	TO88	R03E	5-9	A, B, E
							FULL FACE	D
A31058	RIVER CITY STONE CO	HOLY CROSS	SW	12	TO90	R02W	FULL FACE	A, B, D, E
A31060	BARD CONCRETE	CASCADE EAST	SE	22	TO87	R01W	1-5	A, B, D
							2-5	E
A31064	RIVER CITY STONE CO	WEBER	NE	32	TO89	R02E	3-9A	A, B, D, E
A31066	RIVER CITY STONE CO	FILLMORE	SW	26	TO87	R01W	FULL FACE	A, B, D
							2-4	E
A49002	BELLEVUE S & G CO	BELLEVUE	SW	25	TO87	R04E	1-3	A, B, D, E
A49008	WENDLING QUARRIES INC	IRON HILL	SW	16	TO85	R02E	1-6	A, B, D, E
A49010	WENDLING QUARRIES INC	ANDREW	NW	21	TO85	R03E	1B-5B	A, B, D, E
A49012	WENDLING QUARRIES INC	FROST	SE	16	TO84	R03E	1A-1E	A, B, D, E
A49016	WENDLING QUARRIES INC	WEIS	SE	22	TO85	R04E	7	A, B, D, E
A49018	WENDLING QUARRIES INC	PATASKA	NW	23	TO85	R05E	1	A, B, D, E
A49020	WENDLING QUARRIES INC	PRESTON	SW	26	TO84	R05E	1-10	D, E
							7-10	A, B, D, E
A49021	PRESTON READY MIX	PRESTON R/M	SW	26	TO84	R05E	7-10	A, B, D, E
A49022	WENDLING QUARRIES INC	BELLEVUE	SE	23	TO86	R04E	1B-3	A, B, D, E
A49024	WENDLING QUARRIES INC	MAQUOKETA EAST	SW	07	TO84	R03E	1-8	A, B, D, E
A49040	WENDLING QUARRIES INC	JOINERVILLE	SE	20	TO84	R02E	1-3	A, B, D, E
A52002	WENDLING QUARRIES INC	FOUR COUNTY	NW	04	TO81	R08W	9-16	D
A53002	BARD CONCRETE	FARMERS-BEHRENDS	NE	14	TO86	R03W	1-5	A, B, D, E
A53004	WENDLING QUARRIES INC	MONTICELLO	NE	24	TO86	R04W	FULL FACE	A, B, D, E
010	WENDLING QUARRIES INC	BALLOU-OLIN	NE	24	TO83	R03W	FULL FACE	A, B, D, E
3012	WENDLING QUARRIES INC	WYOMING		33	TO84	R01W	1-2C	A, B, D, E

REVETMENT STONE
SOURCE APPROVAL

DISTRICT 6 (Continued)

CODE	OPERATOR	SOURCE NAME	LOCATION				BEDS	REVETMENT CLASS
A53014	WEBER STONE CO	JACOBS-SCOTCH GROVE	SW	07	T085	R02W	FULL FACE	A, B, D, E
A53016	WEBER STONE CO	STONE CITY	E2	06	T084	R04W	1, 3	A, B, D, E
A53018	RIVER CITY STONE CO	FINN	NE	06	T085	R01W	2-5	A, B, E
							FULL FACE	D
							4-5	E
A53024	RIVER CITY STONE CO	SULLIVAN	NW	14	T086	R03W	FULL FACE	A, B, D, E
A53026	RIVER CITY STONE CO	ANAMOSA	SW	15	T084	R04W	REEF MATERIAL	A, B, D, E
A57002	WENDLING QUARRIES INC	BETENBENDER-COGGON	SW	03	T086	R06W	1-10	A, B, D, E
A57006	WENDLING QUARRIES INC	ROBINS	NE	21	T084	R07W	1-3	D
A57008	WENDLING QUARRIES INC	BOWSER-SPRINGVILLE	SW	29	T084	R05W	1-8	A, B, D, E
A57010	WENDLING QUARRIES INC	TROY MILLS	SE	09	T086	R07W	FULL FACE	D
A57014	WENDLING QUARRIES INC	SWEETING	NW	18	T085	R08W	1-4	D
A57018	MARTIN MARIETTA	CEDAR RAPIDS	NE	15	T082	R06W	2-9	A, B, D, E
A57028	WENDLING QUARRIES INC	BEVERLY	NW	07	T082	R07W	6-7	A, B, E
							1-7	D
A57030	BRUENING ROCK PROD INC	HENNESSEY	NE	01	T082	R07W	9-14, 15-16	D
A70002	WENDLING QUARRIES INC	MOSCOW	NW	08	T078	R02W	11-17	D, E
							21A-24	A, B, D, E
							1-9	EROSION
A82002	RIVERSTONE GROUP INC	MCCAUSLAND	W2	17	T080	R04E	1-19	A, B, D, E
A82004	RIVERSTONE GROUP INC	NEW LIBERTY	NE	33	T080	R01E	1-2	A, B, D, E
A82006	RIVERSTONE GROUP INC	LECLAIRE	NW	35	T079	R05E	2-32	A, B, D, E
AIL006	RIVERSTONE GROUP INC	MIDWAY (MC 45), ROCK IS CO	SW	16	T018	R02E	0-160'	A, B, D, E
AIL010	RIVERSTONE GROUP INC	ALLIED (MC 30), ROCK ISLAND CO		14	T017	R02W	16'-173'	A, B, D, E
AIL016	RIVERSTONE GROUP INC	CLEVELAND (MC 31), HENRY CO	SW	31	T017	R02E	10'-215'	A, B, D, E

APPROVED PRODUCERS
WITH QC PROGRAMS

PRODUCER	STREET ADDRESS	CITY, STATE, ZIP	PHONE/FAX NUMBER
A			
A-LINE CRUSHING SERVICE	808 DEARBORN AVE	WATERLOO, IA 50703	319-232-3889
ACME FUEL & MATERIALS CO	2544 PETTIBONE AVENUE	MUSCATINE, IA 52761	563-263-1105
AGGREGATE INDUSTRIES	2915 WATERS ROAD STE 105	EAGAN, MN 55121	651-686-2302
AGGREGATE MATERIALS CO	1400 E 12TH STREET	DUBUQUE, IA 52001	563-583-6642
AGGREGATES INC	6101 BLAIRS FERRY ROAD NE	CEDAR RAPIDS, IA 52411	319-395-0050
ANDERSON SAND & GRAVEL CO	2578 270TH AVENUE	DEWITT, IA 52742	563-659-5506
ARCADIA LIMESTONE CO	19011 CRYSTAL AVENUE	ARCADIA, IA 51430	712-689-2299
B			
BMC AGGREGATES LC	101 BMC DRIVE	ELK RUN HEIGHTS, IA 50707	319-235-6583 319-235-7065 **(FAX)**
BARD CONCRETE CO	2021 325TH AVENUE	DYERSVILLE, IA 52040	563-875-7145 563-875-7860 **(FAX)**
BEDROCK GRAVEL CO	3527 320TH STREET	AUBURN, IA 51433	712-688-2418
BELLCO OF NEBRASKA INC	2826 SOUTH AVENUE	COUNCIL BLUFFS, IA 51503	712-322-8501 712-322-8526 **(FAX)**
BELLEVUE SAND & GRAVEL CO	29427 HWY 52	BELLEVUE, IA 52031	563-872-3886
BENTON'S SAND & GRAVEL	815 CENTER STREET	CEDAR FALLS, IA 50613	319-266-2621 319-266-5926 **(FAX)**
BIG STONES QUARRY, INC	2487 290TH STREET	PERU, IA 50222	515-988-4106 515-440-0944 **(FAX)**
BLAZEK CORPORATION	1830 RIDGEWAY BLVD	LAWLER, IA 52154	563-238-7150
BOGGESS CONST CO	321 NORTH 17TH COURT	ESTHERVILLE, IA 51334	712-867-4516
BOON CONSTRUCTION CO	N 5399 STATE HWY 73	NEILLSVILLE, WI 54456	
BOYER SAND & ROCK INC	4162 BIRCH AVENUE	HAWARDEN, IA 51023	712-552-2308
BROCKMAN SAND CO	2397 263RD AVENUE-POB 312	FORT MADISON, IA 52627	319-372-7138
BRUENING ROCK PRODUCTS INC /SKYLINE CONSTRUCTION	325 WASHINGTON STREET-POB 127	DECORAH, IA 52101	563-382-2933 563-382-8375 **(FAX)**
BUILDERS SAND & CEMENT CO	104 WESTERN AVENUE	DAVENPORT, IA 52801	563-322-1757
C			
C. J. MOYNA & SONS INC	24412 HWY 13	ELKADER, IA 52043	563-245-1442
CARNARVON SAND & GRAVEL	811 N 10TH ST	DENISON, IA 51442	712-664-2511
CEMSTONE PRODUCTS COMPANY	2025 CENTRE POINT BLVD- SUITE 300	MENDOTA SPRINGS, MN 55120-1221	651-688-9292
CENTRAL STONE CO #1	RR 1-POB 236	HANNIBAL, MO 63401-9622	573-735-4525
CESSFORD CONST CO	2320 ZELLER AVENUE	LE GRAND, IA 50142	641-479-2695 641-479-2003 **(FAX)**
CESSFORD CONST CO - SE DIV	3808 OLD HWY 61	BURLINGTON, IA 52601	319-753-2297 319-753-0926 **(FAX)**
COHRS CONSTRUCTION INC	15700 NORTH TRADEWIND DRIVE	SPIRIT LAKE, IA 51360	712-832-3714
CONCRETE INC	POB 54	GIFFORD, IA 50259	641-858-3637
CONCRETE MATERIALS CO	1201 WEST RUSSELL	SIOUX FALLS, SD 57104	605-357-6000
CONRECO INC	4901 G STREET	OMAHA, NE 68117	402-733-4100 402-733-5774 **(FAX)**
COOTS MATERIALS CO INC	1700 WEST D STREET	VINTON, IA 52349	319-472-4480 319-472-4485 **(FAX)**
CORELL RECYCLING	200 SOUTH 13TH STREET	WEST DES MOINES, IA 50265	515-223-8010
CRAWFORD QUARRY CO	HWY 94 NW-POB 1027	CEDAR RAPIDS, IA 52046	319-396-5705
CROELL REDI MIX	POB 430	NEW HAMPTON, IA 50659	641-394-3770

APPROVED PRODUCERS
WITH QC PROGRAMS

PRODUCER	STREET ADDRESS	CITY, STATE, ZIP	PHONE/FAX NUMBER
D			
DAVE'S SAND & GRAVEL INC	RR 2-POB 58A	HARTLEY, IA 51346	712-834-2515
DOUDS STONE INC	13133 ANGLE RD SUITE B-POB 187	OTTUMWA, IA 52501	641-683-1671 641-683-1673 **(FAX)**
DUININCK BROS INC	408 6TH ST-POB 208	PRINSBURG, MN 56281	320-978-6011
E			
ESTHERVILLE ROCK & GRAVEL CO	POB 97	ESTHERVILLE, IA 51344-0097	712-362-3506 800-379-7263 (T-F)
F			
FALK L R- CONSTRUCTION CO	227 W 4TH STREET-POB 189	ST ANSGAR, IA 50472-0189	641-713-4569
FALKSTONE LLC	227 W 4TH STREET-POB 189	ST ANSGAR, IA 50472-0189	641-713-4569
FLEWELLING SAND & GRAVEL	1157 HWY 140	MOVILLE, IA 51039	712-873-3174
FLOYD RIVER MATERIALS	32138 HICKORY AVE	SIOUX CITY, IA 51101	712-233-1111
FORT CALHOUN STONE CO	7001 US HWY 75-POB 284	BLAIR, NE 68008	402-426-4254 402-468-4380 402-468-4388 **(FAX)**
FORT DODGE ASPHALT CO	2516 7TH AVENUE SOUTH	FORT DODGE, IA 50501	515-573-3124
FRED CARLSON COMPANY	POB 48	DECORAH, IA 52101	563-382-4249
G			
GEHRKE QUARRIES INC	POB 521	ELDORA, IA 50627	641-858-3821 641-858-2564 **(FAX)**
GRAY QUARRIES INC	POB 386	HAMILTON, IL 62341	217-847-2712
GREENE LIMESTONE CO	1211 SOUTH MAIN ST-POB 687	CHARLES CITY, IA 50616	641-228-4255 641-228-4061 (Shop)
H			
HAHN READY MIX	POB 1107	MUSCATINE, IA 52761	563-263-6467
HALLETT MATERIALS CO	5550 NE 22ND STREET-POB3365	DES MOINES, IA 50316	515-266-9928 515-266-9857 **(FAX)** 800-838-2615 (WIA)
HANK STALP GRAVEL CO	1598 RIVER ROAD	WEST POINT, NE 68788	402-372-5491 800-372-5491 (T-F) 402-372-5477 **(FAX)**
HEARTLAND ASPHALT INC	2601 SOUTH FEDERAL AVENUE	MASON CITY, IA 50401	641-424-1733
HECKETT-MULTISERV	C/O NSS-HWY 38 & GREENS ROAD	WILTON, IA 52778	563-732-4010 563-732-4011 **(FAX)**
HECKETT MULTISERV WEST	C/O NSW-POB 474	STERLING, IL 61081	815-626-3316 815-626-9306 **(FAX)**
HEIMES EXCAVATING & UTIL CO	9144 SOUTH 147TH STREET	OMAHA, NE 68138	402-894-1000
HIGMAN SAND & GRAVEL INC	16485 HWY 12-POB 109	AKRON, IA 51001	712-568-2181
HORSFIELD MATERIALS, INC.	505 EAST MAIN ST-POB 305	EPWORTH, IA 52045	563-876-3335
I			
IDEAL SAND CO	3902 MT PLEASANT ST-POB 416	WEST BURLINGTON, IA 52655	319-754-4747
IOWA DRAINAGE INC	703 E. GILMAN ST- POB 7	SHEFFIELD, IA 50475	641-892-4330
IRON MOUNTAIN TRAPROCK CO	POB 9137	IRON MOUNTAIN, MO 63650	573-734-6106
J			
J W READY MIX & CONST	3111 270TH STREET	SAC CITY, IA 50583	712-662-4239

APPROVED PRODUCERS
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PRODUCER	STREET ADDRESS	CITY, STATE, ZIP	PHONE/FAX NUMBER
K			
KERFORD LIMESTONE CO	36110 FLETCHER STREET	WEEPING WATER, NE 68463	402-267-2415 402-267-5240 **(FAX)**
KNIFE RIVER	POB 229	STRATFORD, IA 50249	515-838-2475 515-838-2472 **(FAX)**
KNOCKS BUILDING SUPPLIES	302 NORTH SIDE	PARKERSBURG, IA 50665	319-278-4868
KRUSE PAVING INC	POB 899	LAKEFIELD, MN 56150	507-662-5205 507-662-6725 **(FAX)**
KRUSE ROCK & GRAVEL	1401 T AVENUE-POB 466	MILFORD, IA 51351	712-338-9084 888-808-7625 (T-F) 712-338-2031 **(FAX)**
KUHLMAN CONSTRUCTION CO	325 MAIN-POB 126	COLESBURG, IA 52035	563-856-3535 800-772-1731 (T-F) 563-856-5505 **(FAX)**
L			
L G EVERIST INC	POB 9	DELL RAPIDS, SD 57022	605-428-5419 605-428-3012 **(FAX)**
L&M SAND & GRAVEL INC	426 2ND AVENUE NE	LE MARS, IA 51031	712-546-5359
L&W QUARRIES INC	POB 335	CENTERVILLE, IA 52544	641-437-4830 641-437-4837 **(FAX)**
LA HARV CONST CO INC	POB 267	FOREST CITY, IA 50436	641-581-3643
LESSARD CONTRACTING INC	POB 705	SERGEANT BLUFF, IA 51054	712-252-4131
LINWOOD MINING & MINERALS CORP	5401 VICTORIA AVE, SUITE 110	DAVENPORT, IA 52807	563-359-8251 800-798-8251 (T-F) 563-344-3730 **(FAX)**
LOUNSBURY LANDSCAPING	6000 RACCOON RIVER DR	WEST DES MOINES, IA 50266	515-225-7100
LUNDELL CONSTRUCTION CO., INC	1420 EAST RICHLAND	STORM LAKE, IA 50588	712-732-4059
LYMAN-RICHEY SAND & GRAVEL	4315 CUMING STREET	OMAHA, NE 68131	402-558-2727
M			
MALLARD SAND & GRAVEL	POB 638	VALLEY, NE 68064	402-359-5287
MANATT'S INC	1755 OLD 6 ROAD-POB 535	BROOKLYN, IA 52211	641-522-9206 641-522-9407 **(FAX)** 641-522-5594 **(FAX)**
MANATT'S SAND & GRAVEL	1928 340TH STREET-POB 87	TAMA, IA 52339	641-484-4022
MARENGO READY MIX INC	POB 121	MARENGO, IA 52301-0121	319-642-3811
MARTIN MARIETTA AGGREGATES	11252 AURORA AVENUE	DES MOINES, IA 50322	515-254-0030 800-332-5433 (T-F) 515-254-0035 **(FAX)**
MARTIN MARETTA AGGREGATES	POB 629	VALLEY, NE 68064	402-359-4088
MATX INC	110 CLUBRIDGE PLACE	COLORADO SPRINGS, CO 80906	
MCALISTER AGGREGATES LLC	1924 HWY 141- POB 157	BAYARD, IA 50029	800-642-6653 712-651-2018 **(FAX)**
MIELKE'S QUARRY	13303 SPOOK CAVE RD	MCGREGOR, IA 52157	563-539-4227
MILESTONE MATERIALS	920 10TH AVE NORTH-POB 189	ONALASKA, WI 54650	608-783-6411 608-783-4311 **(FAX)**
MOBERLY STONE CO	POB 582	MOBERLY, MO 65270	660-277-4419 660-277-4790 **(FAX)**
MOLO SAND & GRAVEL CO	123 SOUTHERN AVENUE	DUBUQUE, IA 52001	563-557-7540
MYRL & ROY'S PAVING INC	1300 NORTH BAHNSON AVENUE	SIOUX FALLS, SD 57103	605-334-3204 605-334-0468 **(FAX)**

APPROVED PRODUCERS WITH QC PROGRAMS

PRODUCER	STREET ADDRESS	CITY, STATE, ZIP	PHONE/FAX NUMBER
N			
NATURAL MATERIALS, L.L.C.	1408A HWY 44, SUITE 800	HARLAN, IA 51537	712-755-2563 712-755-5344 **(FAX)**
NELSTAR	210 WALNUT	MERIDEN, IA 51037	712-443-8832
NEW ULM QUARTZITE QUARRY	ROUTE 5-POB 21	NEW ULM, MN 56073	507-354-2925 507-359-7870 **(FAX)**
NORRIS AGGREGATES CO	219 3RD ST-POB 190	CAMERON, MO 64429	816-324-0310
NORTH IA SAND & GRAVEL INC	18237 KILLDEER AVENUE	MASON CITY, IA 50401	641-424-5591 641-423-1894 **(FAX)**
NORTHWEST MATERIALS	1648 LAINSON AVENUE	FORT DODGE, IA 50501	515-573-8921
NORTHWEST R/M CONCRETE INC	6340 180TH STREET	OCHEYEDAN, IA 51354	712-758-3683
NU AGGREGATES	300 NORKA DRIVE	AKRON, IA 51001	712-568-2181
O			
ORTONVILLE STONE CO	POB 67	ORTONVILLE, MN 56278	320-839-6131
P			
PATRICK M. PINNEY CONTRACTORS	1915 FLOYD BLVD-POB 5107	SIOUX CITY, IA 51102	712-252-2774
PAUL NIEMANN CONST CO	24541 150TH STREET-POB 128	SUMNER, IA 50674-0128	563-578-3261 563-578-3263 **(FAX)**
PBI CONST	4953 D AVE	MARCUS, IA 51035	712-376-4886
PEDERSON BROTHERS	POB 606	HARMONY, MN 55939-0606	507-498-3377
PELLA CONST CO LTD	POB 25	PELLA, IA 50219	641-628-3840
PERSINGER SAND & GRAVEL	3281 LUCAS AVENUE	SMITHLAND, IA 51056	712-889-2258
PERU QUARRY	2431 ST. CHARLES ROAD	WINTERSET, IA 50273	515-462-4801
PETERSON CONTRACTORS INC	104 BLACKHAWK-POB A	REINBECK, IA 50669	319-345-2713
PETTENGILL CONC & GRAVEL INC	800 NORTH BOONE	ROCK RAPIDS, IA 51246	712-472-2571
PRAIRIE SAND & GRAVEL	POB 210	PRAIRIE DU CHIEN, WI 53821	608-326-6471
PRESTON READY MIX CORP	POB 399	PRESTON, IA 52069	563-689-3381
Q			
QUALITY CONCRETE CO	327 17TH AVENUE SOUTH	CLINTON, IA 52732	563-242-3524
R			
RANDALL TRANSIT MIX CO	1343 HWY 105-POB 153	NORTHWOOD, IA 50459-0153	641-324-1063
RECYCLED AGGREGATE PROD CO	2131 18TH STREET	SIOUX CITY, IA 51105	712-252-7732
REDINGS GRAVEL & EXCAVATING CO	2001 EAST OAK STREET	ALGONA, IA 50511	515-295-3661
REILLY CONSTRUCTION CO	110 MAIN STREET-POB 99	OSSIAN, IA 52161	563-532-9211 563-532-9759 **(FAX)**
RIEHM CONSTRUCTION CO INC	2340 9TH STREET SW	WAUKON, IA 52172	563-568-3314
RIVER BEND ENTERPRISES	3000 ASHERTON AVENUE	NASHUA, IA 50658	641-435-2436
RIVER CITY STONE INC	3747 CONSTRUCTORS COURT-POB 160	KEILER, WI 53812-0160	608-568-3433
RIVER PRODUCTS CO INC	3273 DUBUQUE ST NE- POB 2120	IOWA CITY, IA 52244-2120	319-354-1090 319-353-6606 **(FAX)**
RIVERSTONE GROUP INC	1701 5TH AVENUE	MOLINE, IL 61265	309-757-8250 309-757-8257 **(FAX)**
ROCK VALLEY GRAVEL CO	1315 17TH AVENUE-POB 9	ROCK VALLEY, IA 51247	712-476-2063
ROCKY MOUNTAIN ENTERPRISES	6515 COUNTY HIGHWAY H	ATHENS, WI 54411	715-257-1440 715-257-1140 **(FAX)**
ROHLIN CONST CO INC	POB 137	ESTHERVILLE, IA 51344	712-362-3549
ROVERUD CONST CO INC	601 E. MAIN ST-POB 606	SPRING GROVE, MN 55974	507-498-3376 800-622-7625 (T-F) 507-498-5835 **(FA**

APPROVED PRODUCERS WITH QC PROGRAMS

PRODUCER	STREET ADDRESS	CITY, STATE, ZIP	PHONE/FAX NUMBER
S			
S&A CONSTRUCTION LTD	POB 20	ALLENDALE, MO 64420	660-786-2233
S&G MATERIALS	4213 SAND ROAD SE	IOWA CITY, IA 52240	319-354-1667
SCHILDBERG CONSTRUCTION CO	POB 358	GREENFIELD, IA 50849	641-743-2131
SCHMILLEN CONST INC	4772 C AVENUE	MARCUS, IA 51035-0488	712-376-2249
SHELL ROCK PRODUCTS	22281 WALNUT AVENUE	SHELL ROCK, IA 50670	319-885-4302
SHIPLEY CONTRACTING	2671 240TH STREET	FORT MADISON, IA 52625	319-372-1804
SIEH SAND & GRAVEL	101 WEST 18TH STREET-POB 1503	SPENCER, IA 51301	712-836-2244 712-262-4580
SOUTHERN MN CONST CO, INC.	1100 MARCUS ST-POB1100	FAIRMONT, MN 56031	507-235-3321
SPENCER QUARRIES	25341 430TH AVENUE	SPENCER, SD 57374	605-246-2344
STENSLAND GRAVEL CO	1741 ASHLEY AVE	LARCHWOOD, IA 51241	712-477-2280
STERZINGER CRUSHING INC	3273 290TH AVE	TAUNTON, MN 56291	
STONER SAND	RR 2	RIDGEWAY, MO 64481	660-824-4211
SWAN ROCK & SAND PRODUCTS, LLC	27453 210TH AVE-POB125	EDDYVILLE, IA 52553	641-658-2474 641-777-1233 (CELL)
T			
TIEFENTHALER AG-LIME INC	11975 HAWTHORNE AVENUE-POB 157	BREDA, IA 51436	712-673-2686
U			
ULLAND BROTHERS INC	2400 MYERS ROAD	ALBERT LEE, MN 56007	507-373-1960 507-433-1819
W			
WAYNE T HANSEN CORP	13 COUNTRY ESTATES	ALGONA, IA 50511	515-295-5573
WEATHERTON CONTRACTING	307 N 16TH ST-POB151	BERESFORD, SD 57004	605-763-2078
WEBER STONE CO INC	12791 STONE CITY ROAD	ANAMOSA, IA 52205	319-462-3581 319-462-3585 **(FAX)**
WELDEN AGGREGATES INC	POB 832	IOWA FALLS, IA 50126	641-648-5142 641-648-5142 **(FAX)**
WENDLING QUARRIES INC	POB 230	DEWITT, IA 52742	563-659-9181 563-659-3393 **(FAX)**
WEST DES MOINES SAND CO	10500 SW 52ND STREET	DES MOINES, IA 50265	515-287-2340
WESTERN ENGINEERING COMPANY	POB 350	HARLAN, IA 51537	712-755-5191
WETHERELL EXCAV & TRUCKING	POB 582	STORM LAKE, IA 50588	712-732-4059 712-732-2839 **(FAX**
WILTGEN CONSTRUCTION CO	113 EAST MAIN STREET-POB 817	CALMAR, IA 52132	563-562-3301 800-365-3301 (T-F)
WINN CORP SAND & GRAVEL	28825 290TH STREET	OLLIE, IA 52576	641-667-3471
WRIGHT MATERIALS CO	1127 HWY 69-POB 244	BELMOND, IA 50421	641-444-3920
Z			
ZUPKE SAND & GRAVEL	17963 150TH STREET	RANDALIA, IA 52164	563-428-4444

Section 2301. Portland Cement Concrete Pavement

2301.01 DESCRIPTION.

Concrete pavement shall consist of a single course of PCC of the type and class specified in the contract. If the class of concrete is not specified, Class C concrete shall be used.

2301.02 TYPE OF PAVEMENT.

Concrete pavement shall be one of two types, Standard or Slip Form.

A. Standard Concrete Pavement.

Standard concrete pavement may be reinforced or nonreinforced, and shall consist of concrete of the class specified in the contract documents, reinforced as shown in the contract documents, placed within fixed forms, and consolidated and finished by equipment operating on forms.

B. Slip Form Pavement.

Slip form pavement may be reinforced or nonreinforced, and shall consist of concrete of the class specified in the contract documents, reinforced as shown in the contract documents, placed, consolidated, and finished without the use of fixed forms.

Irregularly shaped areas of either type of pavement may be formed and finished by hand methods.

When the contract allows standard or slip form pavement, the type is an option of the Contractor. When the contract allows only one type, the type specified shall be used. When the slip form type is specified, small or irregular areas may be constructed with fixed forms.

Reinforced bridge approach sections shall be placed in accordance with the details and limits shown in the contract documents.

2301.03 MATERIALS.

All materials shall meet requirements for the respective items in Division 41. Unless otherwise specified, coarse aggregate shall be of the durability class required by Article 4115.04.

Compatibility of all material combinations shall be the responsibility of the Contractor. If the concrete materials are not producing a workable concrete mixture, a change in the material may be required. Any changes will be at no additional cost to the Contracting Authority.

2301.04 PORTLAND CEMENT CONCRETE PAVEMENT.

Materials for pavement concrete shall be proportioned in any one of the mixtures identified in the current Materials I.M. 529 for the class of concrete specified in the contract documents. Any of the mixtures may be used, at the Contractor's option, provided the gradation of the separate aggregates complies with the gradation required for that mixture. C-5 and C-6 concrete mix proportions will not be used for pavements on Interstate and Primary highways.

After October 31, all items of concrete pavement specified to be constructed with Class B concrete shall be constructed with Class A concrete. The Engineer either will require completion by continuing placement operations past October 31 or will allow the Contractor the option of a winter shutdown. When completion is required, the Contracting Authority will pay the net increase in cost of materials resulting from the change in proportions for any pavement placed within the contract period or authorized extensions thereof, and other increases in cost shall be at the Contractor's expense.

A. Combined Fine and Coarse Aggregate.

If use of combined fine and coarse aggregate is approved, the proportions will be fixed on the basis of the relative amounts of fine and coarse aggregate contained, so as to be equivalent to one of the appropriate mixes specified for screened aggregates.

The foregoing proportions are based on a specific gravity of 2.62 for Class V aggregate and 2.65 for other aggregates. If the material furnished shows an average specific gravity other than these values, the proportions will be adjusted by the ratio which the actual average specific gravity bears to the foregoing values.

B. Water, Consistency, and Batch Yield.
The amount of mixing water used shall be that which will produce workable concrete of uniform consistency. Except as specifically modified by the Engineer, the slump, measured in accordance with Materials I.M. 317, shall not be less than 1/2 inch (15 mm) or more than 4 inches (100 mm). Slump requirements will not apply to slip form paving.

If it is found impossible to produce concrete having the required consistency without exceeding the maximum allowable water cement ratio specified, the cement content may be increased or water reducing admixture may be added as approved by the Engineer so that the maximum water cement ratio will not be exceeded. Any additional cement or water reducer will be considered incidental, and no additional payment will be allowed.

The basic absolute volume of water per unit volume of concrete is based on average conditions. If characteristics of the material are such that the total quantity of water used to secure the required consistency is such that the batch yield, computed on the basis of absolute volumes of the batch quantities used, is deficient by more than 2.0%, the proportions may be adjusted by the Engineer to correct the yield. Adjustment described in this paragraph will not be a basis for adjustment of the contract unit price.

C. Entrained Air Content.
Air entrainment shall be accomplished by addition of an approved air entraining agent. Air content as determined by Materials I.M. 318, will be determined on each day of production as early and as frequently as necessary until the air content is consistently acceptable. The intended air content of finished concrete is 6.0%. Acceptance for entrained air content will be before consolidation.

1. Slip form projects greater than 7500 square yards (6000 m^2). The target air content will be determined to account for air loss during consolidation of concrete during slip form paving. The difference between before and after the paver air contents for a given location shall be considered the air loss.

On the first day of paving, air loss and target air content will be established during placement of the first eleven loads of concrete. The procedure will be as follows:

a. Central Batch Plant: the air content before the paver shall be between 8.0% and 12.0% until the target air content has been established.

b. Ready Mixed Concrete: the air content before the paver shall be 7.5% plus 1.5% or minus 1.0%, until target air content has been established.

Thereafter, the air loss and target air content will be established once per half day paving. The target air content shall be 6.5%, plus the air loss rounded to the next higher 0.5%, with a tolerance of plus or minus 1.5%. A new target air content before the paver will be established if the air loss deviates by more than 0.5% from the last air loss.

After the first day of paving, the target air content from the previous day will be used until a new target air content is determined.

2. Slip form projects less than 7500 square yards (6000 m^2).
The air content before the paver shall be 7.5% plus 1.5% or minus 1.0%. At the option of the Engineer, the target air content may be established using the air loss.

The air content for non slip form paving shall be 7.0% plus 1.5% or minus 1.0%.

D. Admixtures.
When authorized by the Engineer, approved admixtures complying with Section 4103 may be used.

E. Use of Fly Ash and GGBFS.
The maximum allowable fly ash substitution rate shall be 20%. The GGBFS substitution rate shall be not more than 35% by weight (mass). The total mineral admixture substitution rate shall not exceed 40%. When Type IP or IS cement is used in the concrete mixture, only fly ash substitution will be permitted. Substitution of Type I/II cement with both GGBFS and fly ash will be permitted in ready mix concrete mixtures only. Between October 16 and March 15, fly ash substitution will be allowed only when maturity method is used to determine time of opening.

2301.05 EQUIPMENT GENERAL.

The Contractor shall provide sufficient equipment to perform all operations necessary to complete the work. Equipment shall meet the appropriate requirements of Section 2001 and the following provisions.

2301.06 PROPORTIONING AND MIXING EQUIPMENT.

Equipment used for proportioning and mixing concrete materials shall comply with the following:

A. Weighing and Proportioning Equipment.
Article 2001.20 shall apply.

B. Mixing Equipment.
Article 2001.21 shall apply.

C. Bins.
Article 2001.06 shall apply.

2301.13 PROPORTIONING AND MIXING OF CONCRETE MATERIALS.

The proportioning and mixing materials shall meet the following requirements:

A. Storage and Handling of Aggregates.
Aggregates shall be stored and handled to avoid contamination and frequent variations in specific gravity, gradation, or moisture content of the materials used.

1. Fine and coarse aggregate stored in piles or bins shall be kept entirely separate. When aggregates are trucked to the proportioning plant, the trucks shall dump off a ramp or into a walled pit. In either case, they shall dump onto a floored area. This floor shall consist of a substantial platform or a layer of similar aggregate at least 18 inches (0.5 m) thick placed entirely below the elevation of the surrounding ground.

2. The number of changes from one material to another having different frictional characteristics, class of durability, or average specific gravity shall be reduced to the minimum which the Engineer considers practical.

3. The moisture content of aggregates at time of proportioning or placement in proportioning bins shall be so that water will not drain or drip from a moisture sample.

Aggregates shall be handled in a manner that will prevent variations of more than 0.5% in moisture content of successive batches. Coarse aggregates having an absorption greater than 0.5% shall be thoroughly wetted and allowed to drain for at least 1 hour before being used.

4. Fine aggregate shall be drained at least 24 hours after washing and before batching.

5. Aggregates from two sources shall not be commingled in stockpiles or in the finished pavement, except with approval of the Engineer.

B. Storage and Handling of Cement and Fly Ash.
Cement shall be stored in suitable weatherproof enclosures and shall be handled to prevent loss. Section 4101 shall apply to cement which has developed lumps or which has been stored for extended periods.

Fly ash shall be transported and stored in suitable weatherproof enclosures in a manner to keep it dry. Proportioning equipment shall meet requirements of Article 2001.20, A.

C. Measurement of Materials.
Measurement of materials shall be in accordance with requirements for the type of equipment used and the following additional requirements:

1. Cement scales shall be operated within a delivery tolerance of 1.0% of the mass of cement per batch. When operated manually, scales shall be balanced to tare before each batch is weighed and after each batch is discharged. On all bid items involving more than 6000 square yards (5000 m^2) of pavement or base, except items made up of irregular areas such as crossovers, turn lanes, and etc., the cement and fly ash scales shall have automatic controls which meet the requirements of Article 2001.20, A. Use of manual controls will not be permitted for a period longer than 1 working day after a failure of the automatic controls, except with permission of the Engineer.

On work requiring automatic cement scales, the performance of the scale will be determined near the end of the first full day of production and thereafter at a frequency not to exceed each 10,000 cubic yards (10,000 m^3) of concrete produced, by comparing the accumulated mass of cement proportioned with the corresponding accumulated mass of cement shipped to the project. The cooperation of the Contractor will be required. Cement scale performance determinations are not required when a permanent, commercial ready mix plant is used to furnish less than 10,000 cubic yards (10,000 m^3) of concrete for a contract.

The performance of a fly ash scale, if present, will be determined as above.

2. Aggregate scales shall be operated within a delivery tolerance of 1.0% for each aggregate.

3. Water shall be measured within a delivery tolerance of 1.0% of the intended quantity.

4. Admixtures shall be measured with approved equipment and procedures that assure the quantity measured shall be within a delivery tolerance of 3.0% of the batch quantity. Mechanical dispensing equipment shall be cleaned and flushed out daily and at more frequent intervals if necessary to ensure proper operation.

D. Mixing of Materials.
Concrete materials shall be either mixed at the site of placement or mixed in a construction or stationary mixer to be used for work on the project only, or ready mixed or transit mixed concrete. During any one individual placement; the same cement, aggregates, and

admixtures shall be used throughout the placement unless otherwise approved by the Engineer. With approval of the Engineer, concrete mixtures may be furnished from multiple plants provided the same materials are used in each mixture and mix consistency can be maintained.

1. Concrete Mixed in a Construction or Stationary Mixer.
Concrete materials shall be mixed as provided in Article 2001.21 for the equipment used. The method of handling batches and charging the mixer shall assure complete introduction of each batch separately without loss of materials.

The concrete, as discharged from the mixer, shall be uniform in composition and consistency. If this condition is not produced because of the size of the batch, the size of the batch may be reduced or the mixing time increased, or both, until this result is obtained.

Concrete transported without continuous agitation shall not be used if the period elapsed between the time the concrete is mixed and the time it is placed is greater than 30 minutes. With the approval of the Engineer, an approved retarding admixture may be used at the rate prescribed in Materials I.M. 403, and the mixed-to-placed time period may be extended an additional 30 minutes.

Concrete transported with agitation shall not be used when the time between start of mixing and placement is more than 90 minutes.

The methods of delivering and handling the concrete shall be so that objectionable segregation or damage to the concrete will not occur, and that which will facilitate placing with a minimum of handling.

The compartment in which concrete is transported to the work site shall be thoroughly cleaned and flushed with water at intervals which may be necessary to insure that hardened concrete will not accumulate in the compartment. Flushing water shall be discharged from the compartment before it is charged with the next batch.

Plant operation and procedures shall be subject to the Engineer's approval.

2. Ready Mixed Concrete.
Ready mixed concrete is defined as concrete for which the required materials are as follows:

a. Proportioned in a central plant and mixed in a stationary mixer for transportation in trucks with or without agitation.

b. Proportioned and then mixed in a transit mixer prior to or during transit.

Concrete material shall be mixed as provided in Article 2001.21 for the type of equipment used. When necessary to add additional mixing water at the site of placement, the batch shall be mixed at least an additional 30 revolutions of the drum at mixing speed.

For main portions of the work designed to support public vehicular traffic, it must be demonstrated to the Engineer before the work starts that each vehicle in which concrete will be delivered to the work is capable of discharging concrete having a slump not over 2 inches (50 mm) at an overall rate for its entire load of not less than 1.25 cubic yards (1 m^3) per minute. The concrete shall be delivered at a rate sufficient to maintain a sustained rate of progress of not less than 100 feet (30 m) per hour for the width and depth of slab to be placed. The Engineer shall be assured that an adequate and properly staffed dispatching system will be utilized.

Ready mixed or transit mixed concrete may be used for other portions of the work under other restrictions specified for bid items involving 6000 square yards (5000 m^2) of pavement or less, and may be used for irregular pavement areas such as crossovers and turn lanes.

Concrete transported without continuous agitation shall not be used if the period elapsed between the time the concrete is mixed and the time it is placed is greater than 30 minutes. With the approval of the Engineer, an approved retarding admixture may be used at the rate prescribed in Materials I.M. 403, and the mixed-to-placed time period may be extended an additional 30 minutes.

Concrete transported with agitation shall not be used when the time between start of mixing and placement is more than 90 minutes.

The methods of delivering and handling the concrete shall be such that objectionable segregation or damage to the concrete will not occur, and that which will facilitate placing with a minimum of rehandling.

The compartment in which concrete is transported to the work shall be thoroughly cleaned and flushed with water at intervals that are necessary to ensure that hardened concrete will not accumulate in the compartment. Flushing water shall be discharged from the compartment before it is charged with the next batch.

Plant equipment, operation, and procedures shall be subject to the Engineer's approval.

Section 2403. Structural Concrete

2403.01 DESCRIPTION.

Concrete shall be composed of Portland cement, fine and coarse aggregate, specified or permitted admixtures, and water mixed in proportions specified herein for the various classes.

Unless otherwise specified, structural concrete shall be as follows:

A. Class D Concrete.

Bridge barrier rails shall be Class BR or Class C concrete.

B. Class X Concrete.

Concrete seal courses shall be Class X concrete.

C. Class C Concrete.

Refer to Article 24412.02 for concrete used for one course bridge floors and the first course of two course bridge floors. All other structural concrete, including concrete for bridge curbs, bridge medians, and bridge sidewalks, shall also be Class C concrete.

2403.02 MATERIALS.

All materials used shall meet the requirements for the respective items in Division 41.

Unless otherwise specified, Class 2 durability coarse aggregate, or better, as defined in Article 4115.04, shall be used in structural concrete.

2403.03 PROPORTIONS FOR STRUCTURAL CONCRETE.

Materials for structural concrete may be mixed in proportions for any of the mixes allowed for the class of concrete specified in the contract documents and the current Materials I.M. 529, provided the gradation of each aggregate conforms to the gradation required for that proportion. The contract documents will indicate where each class is to be used and the approximate quantities of each class. At the Contractor's option, Class D or Class M mixtures may be substituted for Class C proportions except in bridge floors.

A. Water and Consistency.

Structural Concrete shall be placed with a slump between 1 inch and 3 inches (25 mm and 75 mm) as a target range, allowing a maximum of 4 inches (100 mm) as a tolerance.

If the characteristics of the materials used are so that the total quantity of water used (including free water in aggregate) to secure the required consistency reduces by more than 2% the batch volume computed on the basis of absolute volumes of the batch quantities used, the proportions may be adjusted accordingly.

If the characteristics of the materials used are so that the required consistency is not secured within the specified maximum water content, the proportions of cement to aggregate shall be increased as necessary to secure the required consistency within the specified maximum water content. Any additional cement will be considered as incidental, and no additional payment will be allowed. The total of mixing water and free moisture in the aggregate shall not exceed the following:

Class of Concrete	Pounds (kg) of Water per Pound (kg) of Cementitious Material
C Separated Aggregate	0.488
X Separated Aggregate	0.444
C with Class V Aggregate	0.444

X with Class V Aggregate	0.422
D57	0.437

When the structural concrete is to be placed in drilled shafts, the concrete shall have a slump of 8 inches " 1 1/2 inches (200 mm " 40 mm) if the drilled hole was constructed using drilling slurry, and a slump of 6 inches " 1 1/2 inches (150 mm " 40 mm) if it is a dry hole.

B. Entrained Air Content.

Air entrainment shall be accomplished by addition of an approved air entraining agent complying with Section 4103. Air content will be tested in accordance with Materials I.M. 318. The intended air entrainment is 6%. To allow for loss during placement, the air content of fresh, unvibrated structural concrete shall be 6.5%, as a target value, with a maximum variation of - 1.0% and + 1.5%.

C. Other Admixtures.

Other approved admixtures may be used with the approval of the Engineer.

Approved retarding admixture complying with Section 4103 may be required by the contract documents or by the Engineer. The retarding admixture shall be used in amounts recommended by the manufacturer for conditions which prevail on the project and as approved by the engineer. When used, it shall be introduced into the mixer after all other ingredients are in the mixer. Other procedures may be approved by the Engineer.

All retarding admixtures used shall be compatible with the air entraining agent used. Previous experience, satisfactory to the Engineer, will be required to indicate the approximate adjustments necessary by the addition of the admixture and compatibility with other materials to be used. The retarding admixture shall be agitated prior to and during its use.

Calcium chloride will not be allowed where reinforcing steel is used.

D. Use of Fly Ash and GGBFS.

The Contractor may use fly ash or GGBFS as a substitute for a portion of the Portland cement in structural concrete. he fly ash and GGBFS shall meet the requirements of Section 4108.The maximum allowable substitution rates shall be 20% for fly ash and 35% for GGBFS with a maximum total mineral admixture substitution rate of 50%.

2403.04 PROPORTIONS FOR LIGHTWEIGHT STRUCTURAL CONCRETE.

When lightweight concrete is specified, the aggregate quality, proportions, mixture characteristics, and controls will be included in the contract documents.

2403.05 EQUIPMENT GENERAL.

Equipment shall meet requirements of Section 2001 and the following articles:

A. Weighing and Proportioning Equipment.

Article 2001.20 shall apply.

B. Mixing Equipment.

Article 2001.21 shall apply.

C. Bins.

Article 2001.06 shall apply.

D. Field Laboratory or Field Office.

Section 2520 shall apply.

2403.06 PROPORTIONING AND MIXING OF CONCRETE.

The respective paragraphs of Article 2301.13 shall apply regarding storage and handling of cement, fly ash, aggregates, measurement of materials, and ready mixed concrete, except for the truck dumping area required in Article 2301.13, A, 1.

A. Mixing of Materials.
Materials shall be thoroughly mixed in an approved mixer at the site of placement or by an approved ready mix plant. The Engineer may withhold approval of use of ready mixed concrete from any plant which has a previous record of unsatisfactory performance.

B. Concrete Mixed on the Site.
Materials mixed in approved mixers at the site of placement shall be mixed in accordance with the specific requirements for the equipment used. The mixing capacity shall be such that finishing operations can proceed at a steady pace with final finishing completed before concrete starts its initial set.

Concrete, as discharged from the mixer, shall be uniform in composition and consistency. Each batch of concrete shall be thoroughly discharged from the mixer before the next batch is introduced. Upon cessation of mixing for any considerable length of time, the mixer shall be thoroughly cleaned and flushed with water.

C. Heating Aggregates.
When aggregates are heated, they shall be heated and handled to avoid damage by overheating and to insure uniform moisture content of aggregate entering the mixer. Aggregates may be heated by steam pipes or coils through aggregate piles. Aggregates shall not be heated by direct, dry heat unless they are mechanically agitated during the heating process.

2403.08 PLACING CONCRETE.

Concrete mixed at the site of the work shall be placed immediately after mixing. Ready mixed concrete shall be placed as soon as practical after delivery, but in all cases within the specified time limit for the equipment used for delivery.

Concrete shall be placed in a manner which will avoid segregation or separation of the ingredients. In placing concrete, all the following precautions shall be observed:

A. In handling concrete from the mixer to the place of deposit, care shall be taken to avoid segregation.

B. When concrete is deposited through a chute, the slope of the chute shall be sloped to allow concrete to flow slowly without segregation. The delivery point of the chute shall be as close as possible to the point of deposit. Chutes and spouts shall be kept clean. They shall be thoroughly flushed with water before and after each run, and the water shall be discharged outside the forms.

Concrete shall not be pumped through aluminum conduit or tubing.

C. A tremie is not required when filling steel shell piles or encasing steel H-piles, but a tremie shall be used whenever the distance through which other concrete must be dropped vertically exceeds 6 feet (2 m), except a 3 foot (1 m) drop shall not be exceeded for bridge floors and culvert slabs. A tremie will not be required for concrete placement of elements which have a maximum dimension no greater than 12 inches (300 mm) provided that the following Part D is adhered to and concrete is placed in lifts.

D. Concrete shall not be deposited in large quantities at a single point and then caused to flow along inside the forms.

E. In depositing concrete, care shall be taken to entirely fill the form without bulging the form or disturbing its alignment.

F. Concrete shall be manipulated and vibrated in a manner to bring a thick layer of mortar into contact with forms and reinforcement and to prevent formation of pockets of coarse aggregate.

G. Concrete shall not be placed in flowing water within the area of a footing. Such flowing water shall be controlled in pipes or trenches outside the forms. In extreme cases, a seal course may be ordered to overcome this difficulty.

H. Structural Concrete placed when the air temperature is at or below 40EF (4EC) shall be protected as provided in Article 2403.11.

An adequate supply of water suitable for washing testing equipment shall be maintained at a convenient location, as directed by the Engineer, near the site of concrete placing operations.

When concrete is being placed during cold weather, the Contractor shall provide an approved, conveniently located shelter, suitable for use in performing on the site tests of the concrete being placed. The shelter shall have a cover, shall be enclosed on at least three sides, and shall be placed to provide maximum protection from the weather.

2403.19 SUBJECTING CONCRETE TO EXTERIOR LOADS.

Concrete may not be subjected to loads other than the load caused by the weight (mass) of the concrete itself except as follows:

A. Loads Producing Simple Compressive Stress Only.

Concrete may be subjected to simple compressive stress as soon as it has set sufficiently to prevent the surface being marred or the edges being chipped from the effect of such loads.

B. Loads Producing Flexural Stresses.

Unless otherwise indicated in the contract documents, concrete may be subjected to loads due to backfilling or to legal traffic when the concrete has reached the minimum age stipulated below and has developed a flexural strength of 550 psi (3.8 MPa) or more:

Minimum Age for Concrete

Portland cement (Type I and Type II with or without Class C fly ash)	7 calendar days
With Class F fly ash substitution	8 calendar days
Class M mix (with or without Class C or Class F fly ash)	3 calendar days
If strength is not determined (regardless of type of cement days or class of fly ash)	14 calendar

The flexural strength shall be determined by testing, in accordance with Materials I.M. 316, specimens of concrete used in the part of the structure in question, cured under conditions similar to those of the concrete in the structure.

Footings for piers supported by piling may be subjected to loads of subsequent pier stem concrete placement not less than 18 hours after footing placement is complete, with no minimum strength requirements.

Unless otherwise specified in the contract documents, at the Contractor's option, the time for subjecting to loads may be determined through the use of the maturity method as described in Materials I.M. 383. When the maturity method is used, the time for loading will be based on strength requirements only, as specified above. The Contractor shall furnish all labor, equipment, and materials necessary for the development of the maturity-strength relationship as described in Materials I.M. 383.

Determining that sufficient strength has been achieved for loading a part of a structure shall remain the responsibility of the Engineer when the maturity method is used. The Contractor's maturity testing may be used as the basis for this determination. The Contractor shall provide sufficient documentation of maturity testing before a part of a structure may be loaded or opened to traffic.

The following shall apply when the maturity method is used:

1. Should circumstances arise which are beyond the Contractor's or Engineer's control and strength cannot be determined by maturity method, the minimum age, minimum flexural strength, and fly ash restrictions shall apply. Flexural strength specimens shall be cured under conditions similar to those of the concrete in the structure.

2. Any changes of a material source or proportion in the concrete mixture shall require a new maturity curve.

Personnel performing maturity testing shall be Level 1 PCC certified technicians, with training for maturity testing. This certified technician may supervise other persons who may then perform the temperature testing of the constructed structure.

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