IOWA | DOT

# AGGREGATE INSTRUCTION TEXT

# 2024-2025


## TECHNICAL TRAINING AND CERTIFICATION PROGRAM

# TECHNICAL TRAINING AND CERTIFICATION PROGRAM
## CONTACT INFORMATION

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# DOT CONTACT INFORMATION

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|---|---|---|
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| John Hart | Bituminous Materials Engineer | 515-239-1547 |
| Brian Johnson | Bituminous Field Engineer | 515-290-3256 |
| Bob Dawson | Chief Geologist | 515-239-1339 |
| Kevin Merryman | Contract Administration Engineer | 515-239-1848 |
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| Desiree McClain | Foundations Field Engineer | 515-233-7906 |
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| Todd Hanson | PCC Materials Engineer | 515-239-1226 |
| Elijah Gansen | PCC Field Engineer | 515-233-7865 |
| Mahbub Khoda | Prestressed & Precast Concrete Engineer | 515-239-1649 |
| Kyle Frame | Structures Group Engineer | 515-239-1619 |
| Curtis Carter | Senior Structures Field Engineer | 515-239-1185 |
| Jesse Peterson | Structures Field Engineer | 515-239-1159 |
| Brian Worrel | Traffic Safety Engineer | 515-239-1471 |
| Mike Lauritsen | District 1 Materials Engineer | 515-357-4350 |
| Robert Welper | District 2 Materials Engineer | 641-422-9421 |
| Vacant | District 3 Materials Engineer | 712-202-0809 |
| Timothy Hensley | District 4 Materials Engineer | 712-243-7629 |
| Allen Karimpour | District 5 Materials Engineer | 515-815-1405 |
| Shane Neuhaus | District 6 Materials Engineer | 319-366-0446 |

# ORGANIZATIONS CONTACT INFORMATION

Asphalt Paving Association of Iowa
1606 Golden Aspen Drive Ste 102
Ames, IA 50010
Mike Kvach 515-450-8166
www.apai.net

Iowa Concrete Paving Association
360 SE Delaware Ave.
Ankeny, Iowa 50021
Greg Mulder 515-963-0606
www.concretestate.org

Iowa Prestress Association
Dennis Drews 402-291-0733

Iowa Limestone Producers Association
4438 114th St
Urbandale, IA 50322
Randy Olson 515-262-8668
www.limestone.org

Iowa Ready Mix Concrete Association
380 SE Delaware Ave.
Ankeny, Iowa 50021
Greg Mulder 515-965-4575
www.iowareadymix.org

# Iowa DOT Websites of Interest

https://www.iowadot.gov/#/services

Home page for the Iowa DOT. Links to all departments and doing business with the Iowa DOT.

https://www.iowadot.gov/training/technical-training-and-certification-program

Training resource page with links to the Technical Training and Certification Program and Web-based training.

https://www.iowadot.gov/Construction_Materials

Office of Construction and Materials home page. It has the Shades program, updated IMs, PCC programs, HMA programs, and Training Information.

https://www.iowadot.gov/erl/index.html

Link to ERL containing Iowa DOT specifications. Also, you can order your own ERL CD. The ERL contains current specifications, general supplementals, and Materials IMs.

https://iowadot.gov/design

Office of Design home page. Contains links to Road Standards and Road Design Details that are referenced in the plans.

https://iowadot.gov/local_systems

Office of Local Systems publications. Contains Iowa gyratory mix design bulletins, local jurisdictions contact information, and Iowa DOT phone book.

# User's Guide for

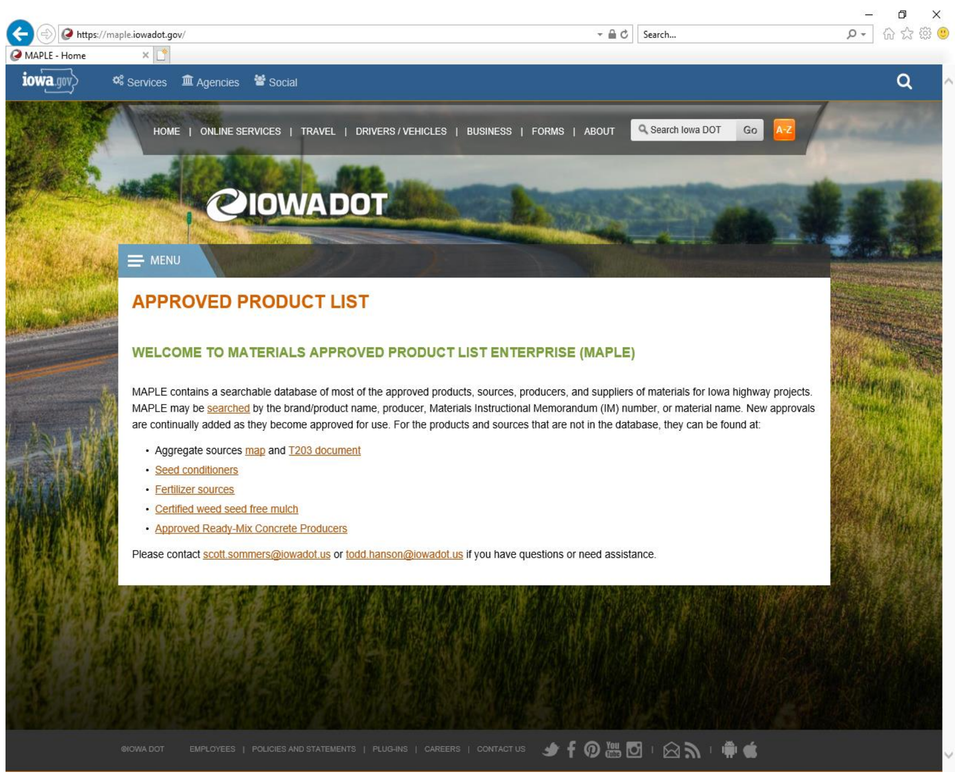
# Materials Approved List Enterprise (MAPLE)

## 1. Introduction

The Iowa DOT Materials Approved List Enterprise (MAPLE) has been in service for all users since July 2014. The MAPLE allows users to check all products approved in Iowa from a single data base. This document is to provide instruction on how to use the MAPLE.

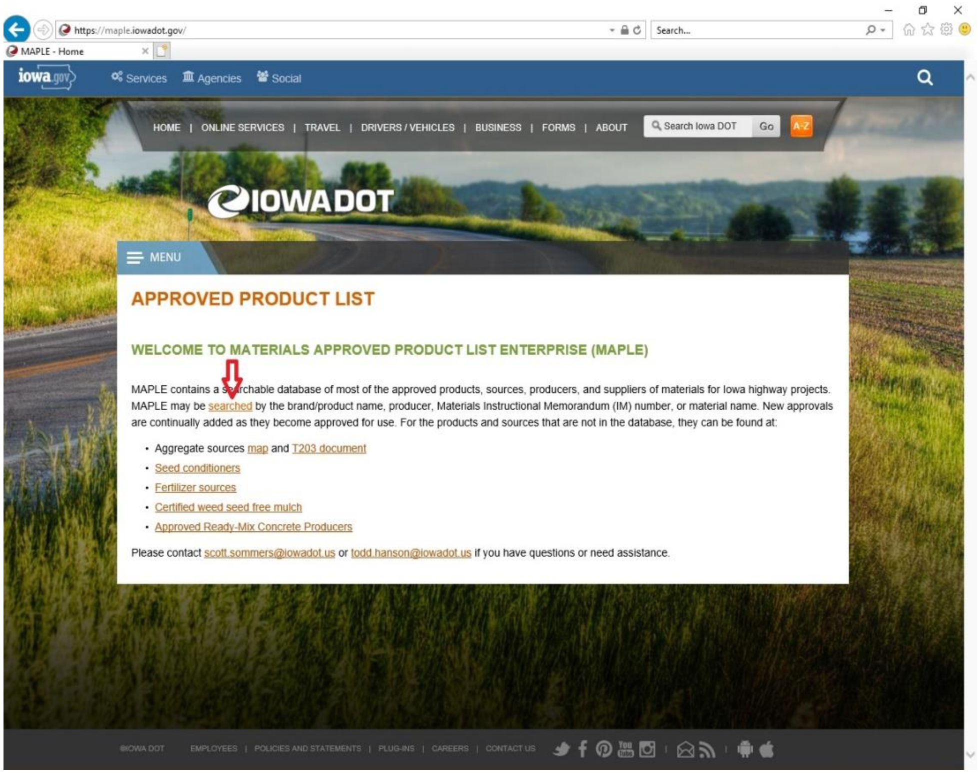
## 2 How to get to MAPLE

The MAPLE can be reached at: https://maple.iowadot.gov/

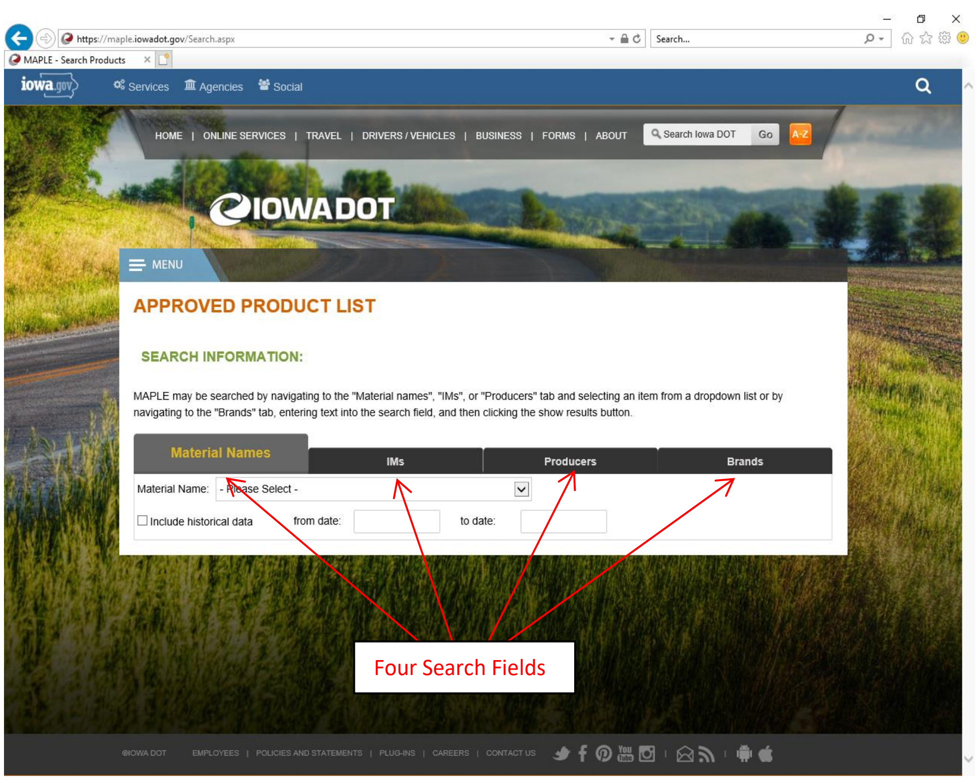


## 3. Searching MAPLE

Click on the **Searched** link as shown below.

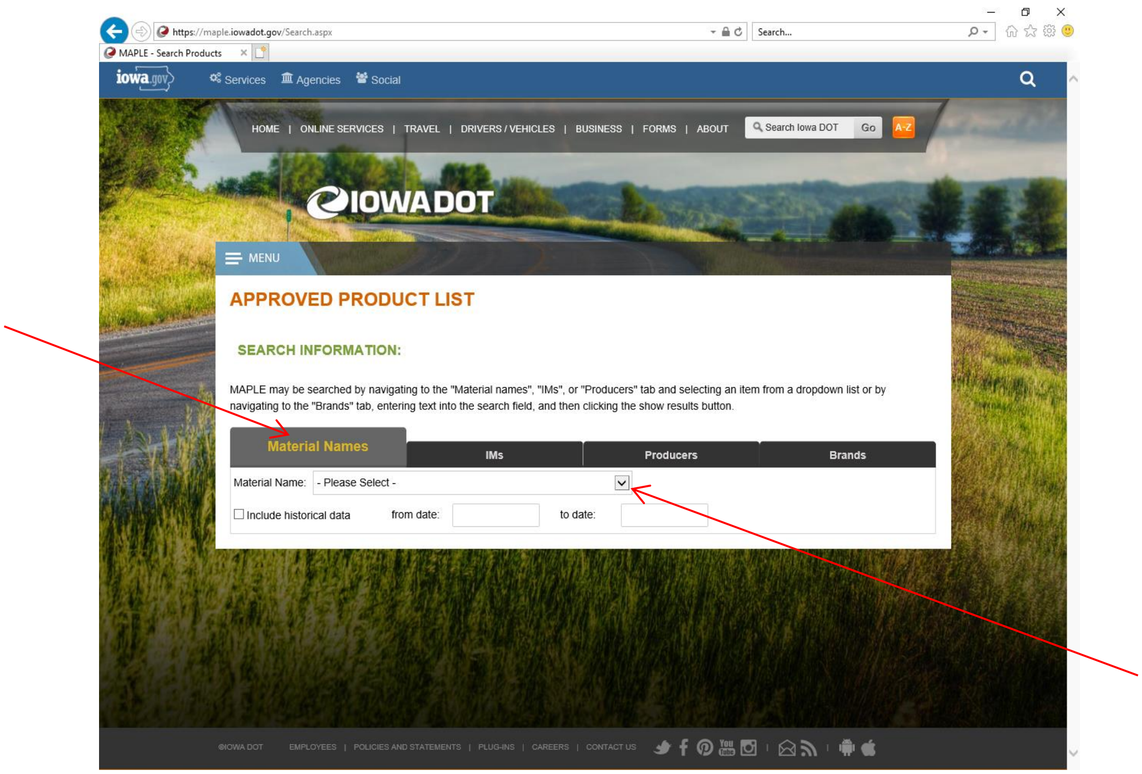


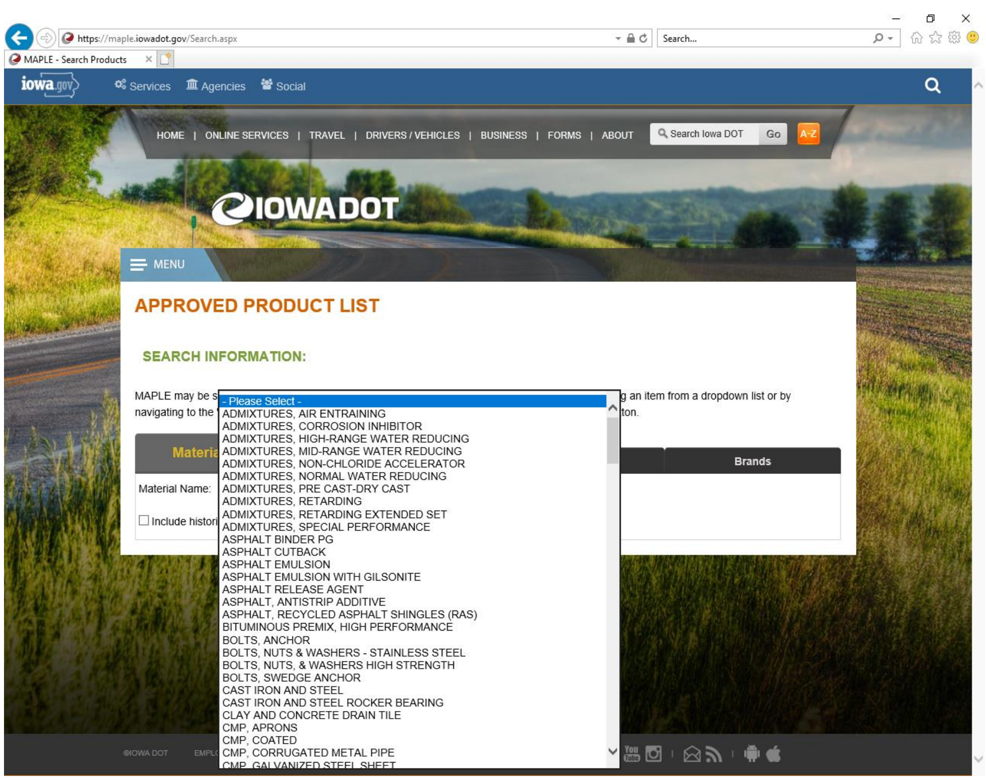

The user can search **MAPLE** through one of four fields listed: **Material Names, IMs, Producers, and Brands**.



## 4. Search by Material Names

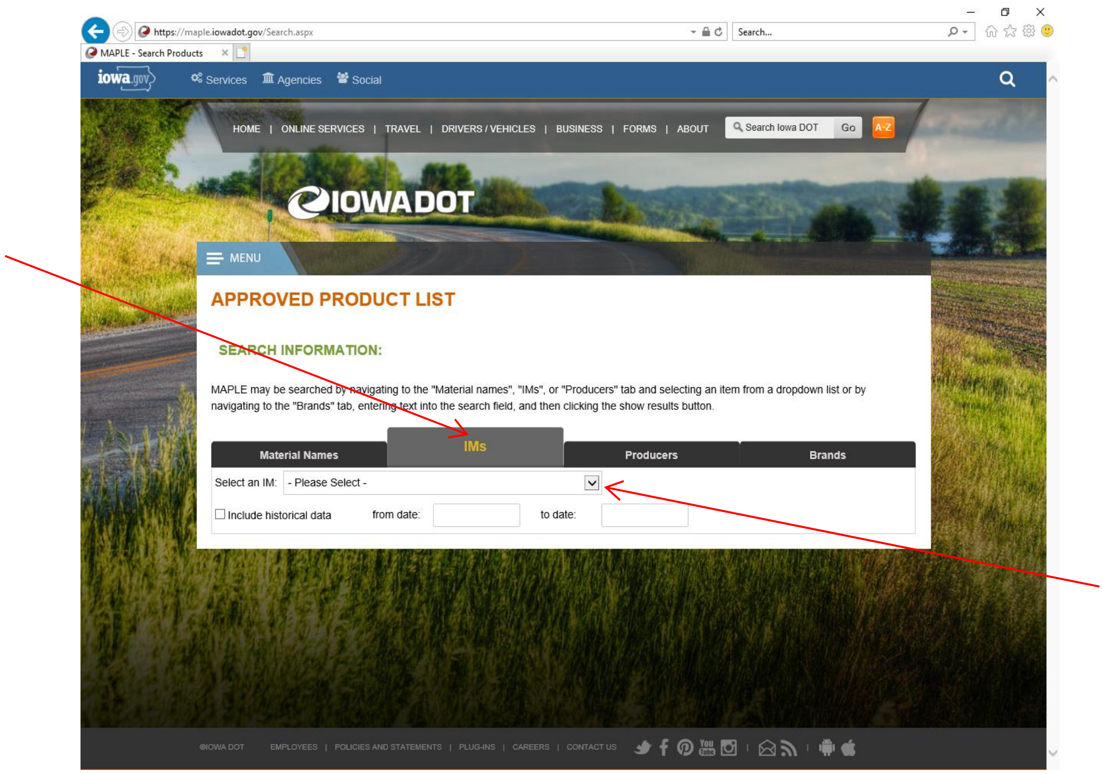
Click on the **Material Names** tab to search by type of material. Click on the arrow and a list will appear as shown. Click on any of the material names to produce an approved product list.

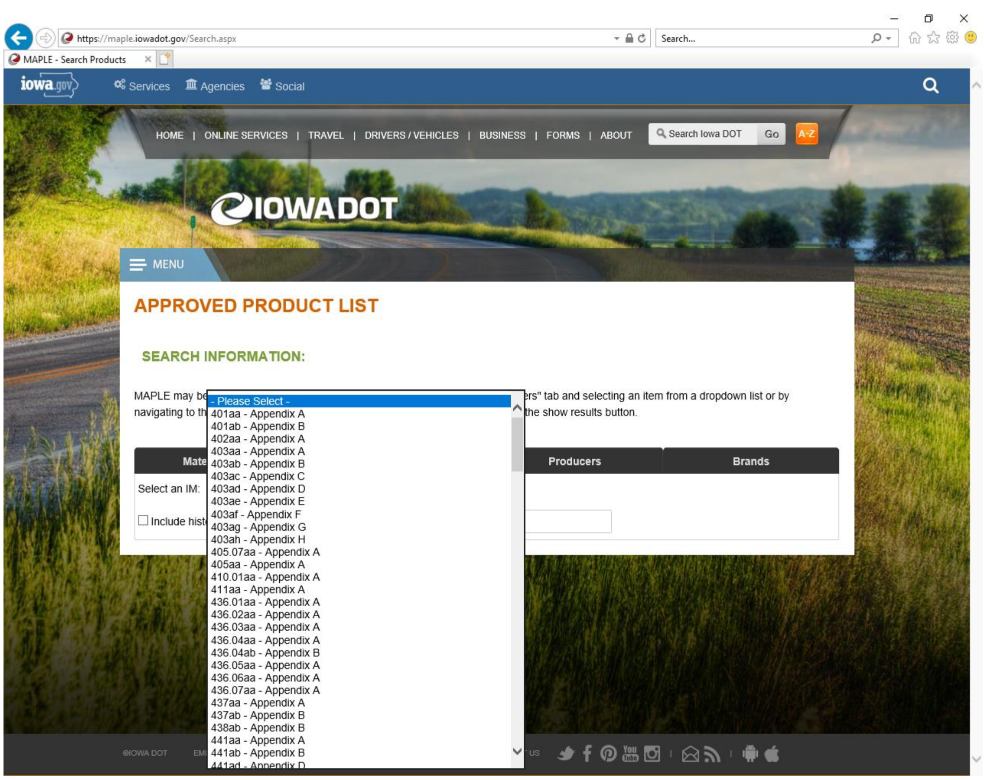


## 5. Searching by IMs

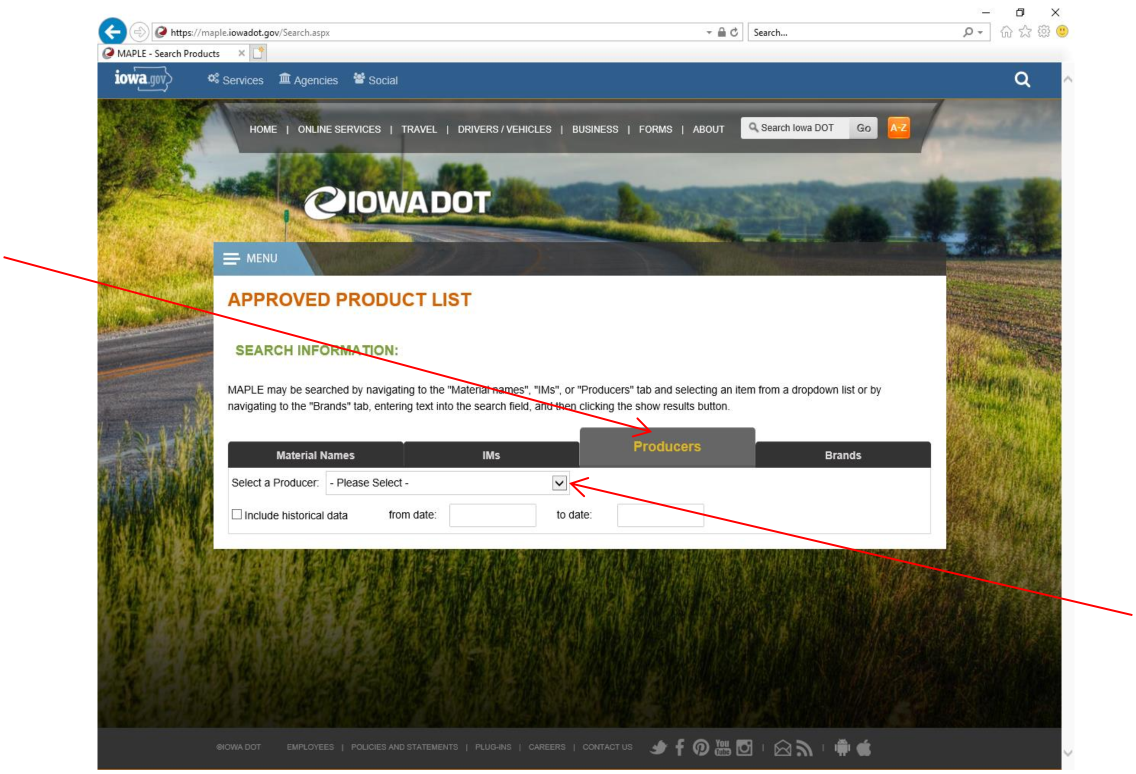
Click on the **IMs** tab to search by IM number. Click on the arrow and a list will appear as shown. Click on any of the IM's listed to produce a list of approved products in that IM.

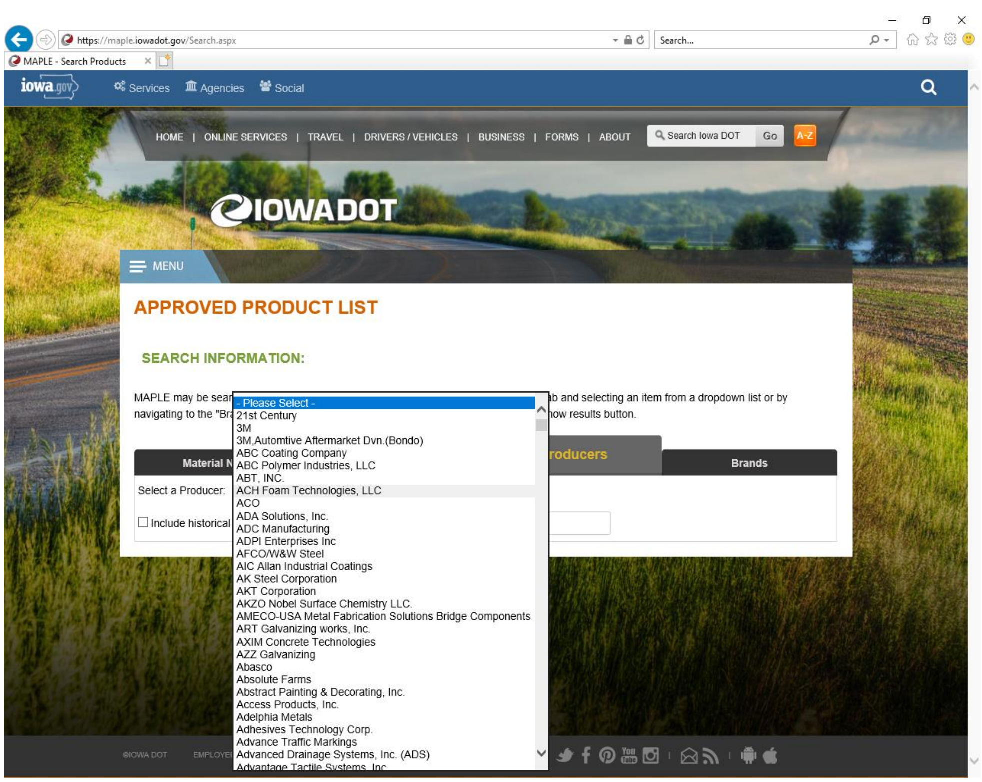


## 6. Searching by Producers

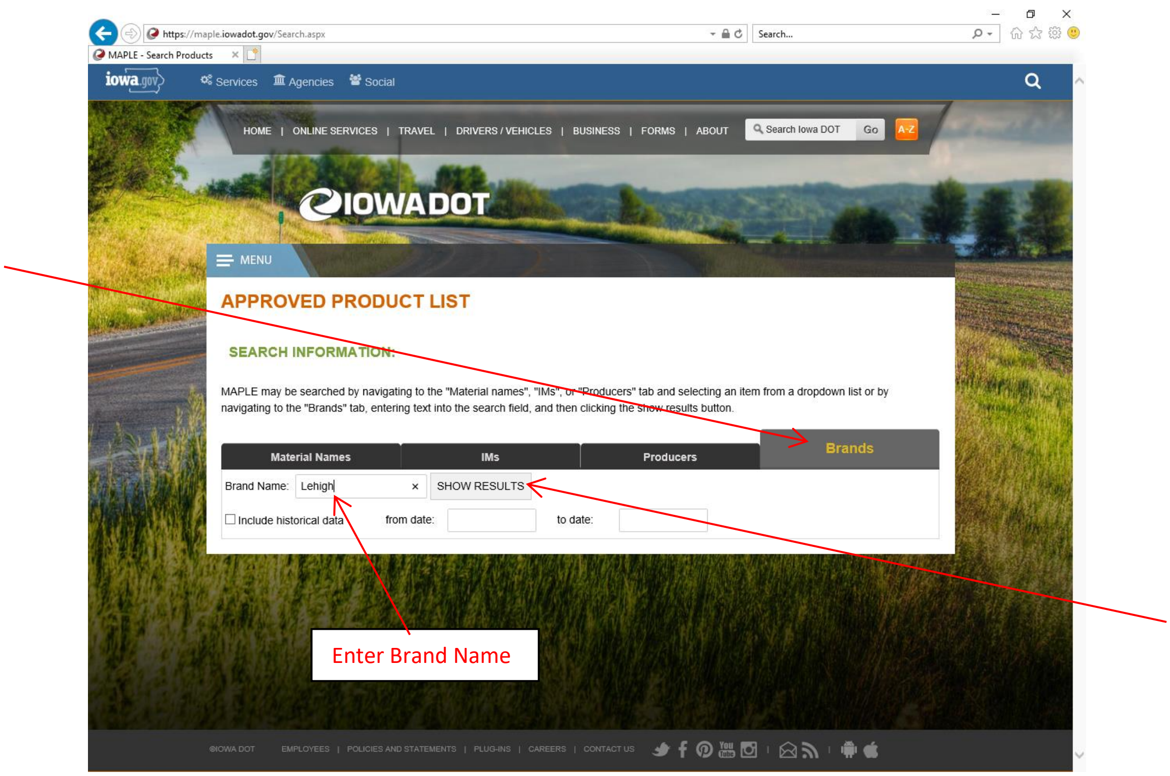
Click on the **Producers** tab to search by producer. Click on the arrow and a list will appear as shown. Click on any producer for a list of all approved products manufactured by that particular producer.

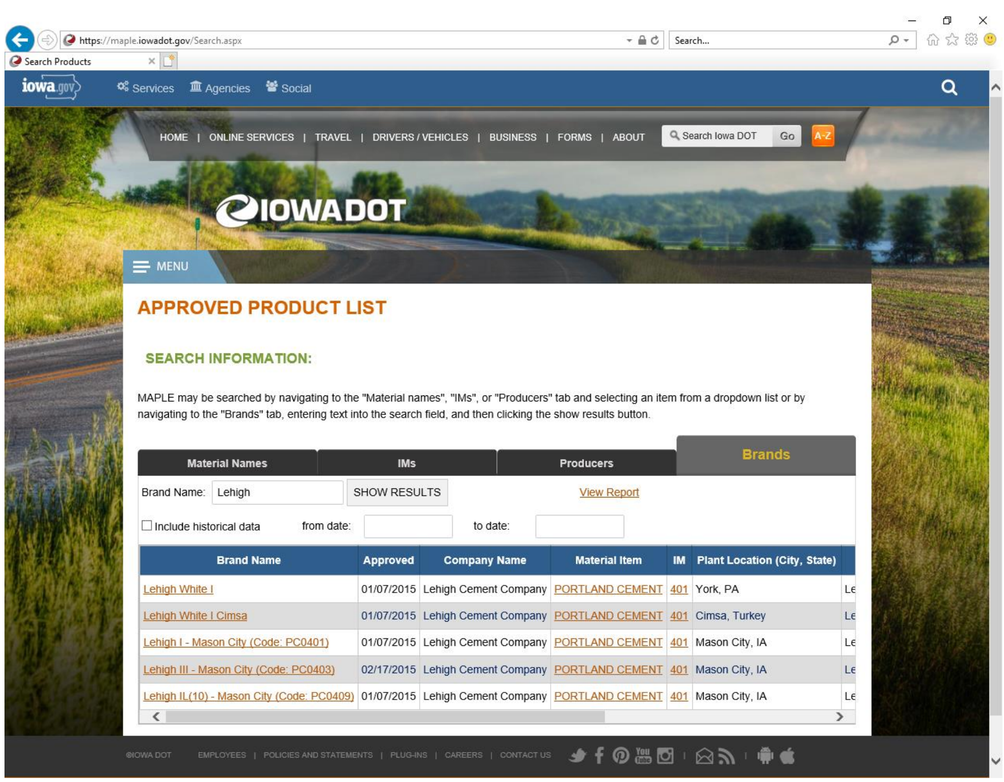


## 7.  Searching by Brand Name

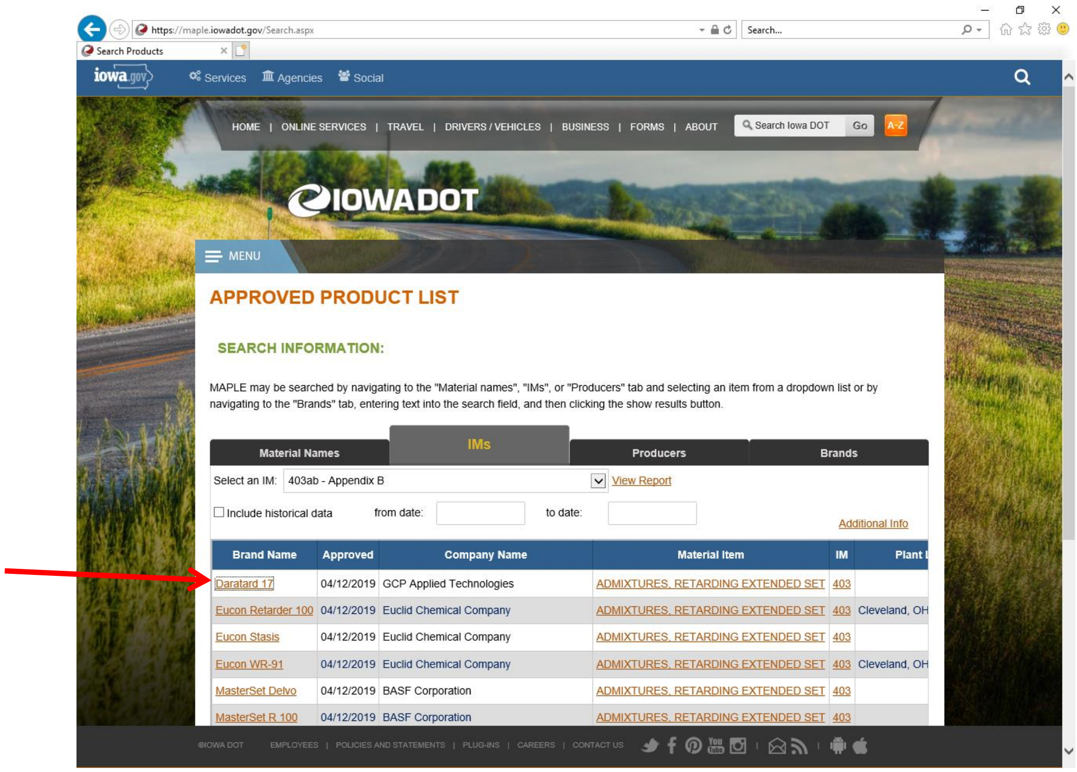
Click on the Brands tab to search by freeform typing the brand name of the product.



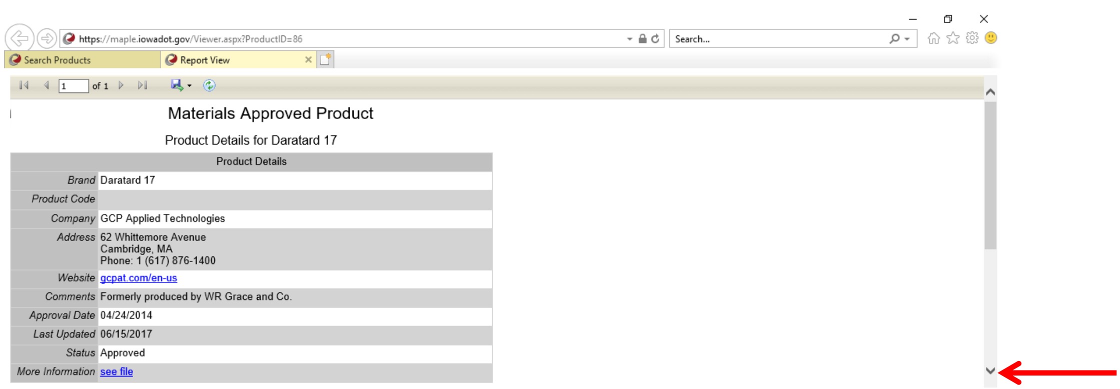



## 8. Selecting a Product

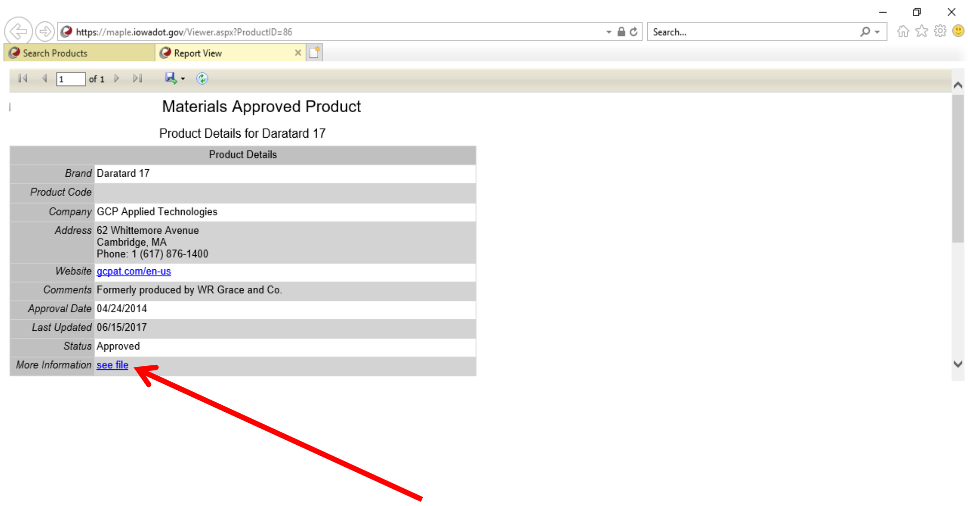
After a list of products has been displayed, click on the individual Brand Name to display more information about the product.



You can use the scroll bar on the right to scroll down for more information.

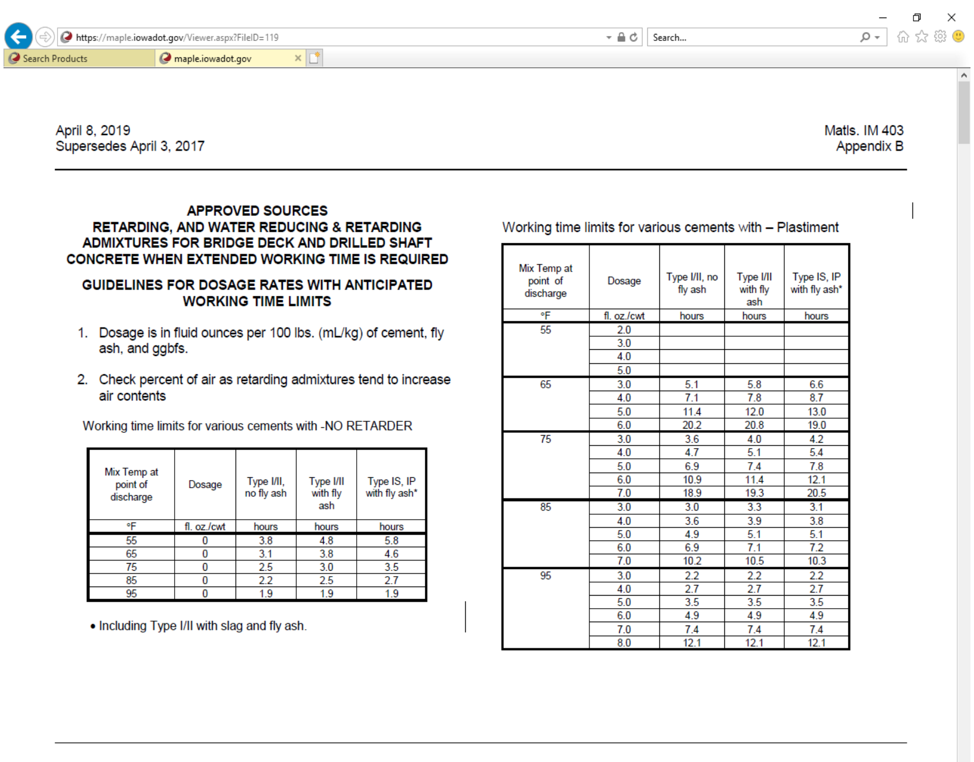


Some products may have a link in the **More Information** field. A pdf with the additional information will appear after clicking on see file. Additional info may be found on the following IM's: 403ab, 445.01ab, 451ad, 455.02aa, 455aa, 462aa, and 557ab.


Materials Approved Product

Product Details for Daratard 17

| Product Details | |
|---|---|
| *Brand* | Daratard 17 |
| *Product Code* | |
| *Company* | GCP Applied Technologies |
| *Address* | 62 Whittemore Avenue<br>Cambridge, MA<br>Phone: 1 (617) 876-1400 |
| *Website* | gcpat.com/en-us |
| *Comments* | Formerly produced by WR Grace and Co. |
| *Approval Date* | 04/24/2014 |
| *Last Updated* | 06/15/2017 |
| *Status* | Approved |
| *More Information* | see file |


April 8, 2019
Supersedes April 3, 2017

Matls. IM 403
Appendix B

**APPROVED SOURCES**
**RETARDING, AND WATER REDUCING & RETARDING ADMIXTURES FOR BRIDGE DECK AND DRILLED SHAFT CONCRETE WHEN EXTENDED WORKING TIME IS REQUIRED**

**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

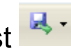
| Mix Temp at point of discharge | Dosage | Type I/II, no fly ash | Type I/II with fly ash | Type IS, IP with fly ash* |
|---|---|---|---|---|
| °F | fl. oz./cwt | hours | hours | hours |
| 55 | 0 | 3.8 | 4.8 | 5.8 |
| 65 | 0 | 3.1 | 3.8 | 4.6 |
| 75 | 0 | 2.5 | 3.0 | 3.5 |
| 85 | 0 | 2.2 | 2.5 | 2.7 |
| 95 | 0 | 1.9 | 1.9 | 1.9 |

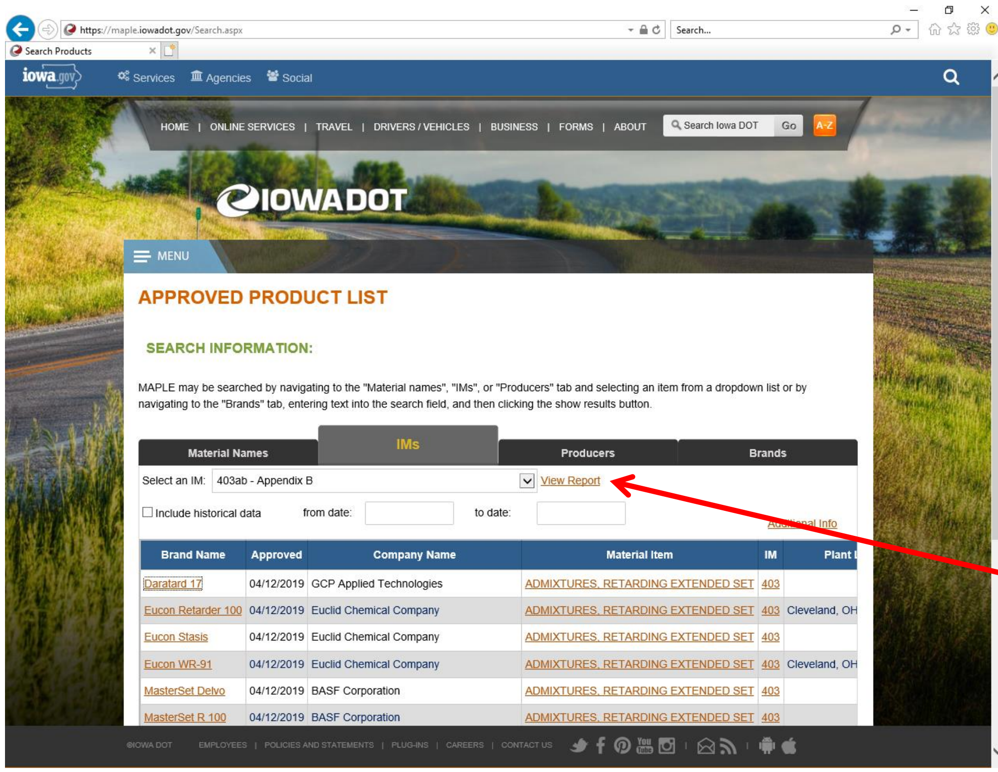
- Including Type I/II with slag and fly ash.

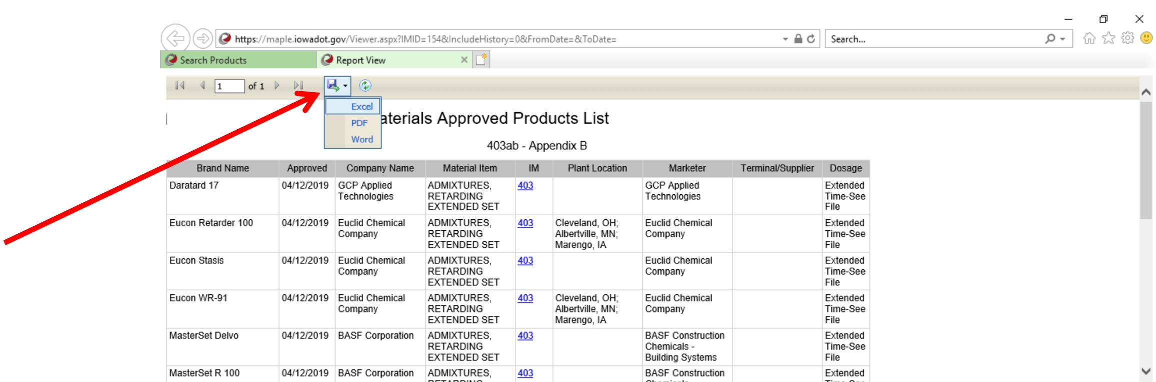
Working time limits for various cements with – Plastiment

| Mix Temp at point of discharge | Dosage | Type I/II, no fly ash | Type I/II with fly ash | Type IS, IP with fly ash* |
|---|---|---|---|---|
| °F | fl. oz./cwt | hours | hours | hours |
| 55 | 2.0 | | | |
| | 3.0 | | | |
| | 4.0 | | | |
| | 5.0 | | | |
| 65 | 3.0 | 5.1 | 5.8 | 6.6 |
| | 4.0 | 7.1 | 7.8 | 8.7 |
| | 5.0 | 11.4 | 12.0 | 13.0 |
| | 6.0 | 20.2 | 20.8 | 19.0 |
| 75 | 3.0 | 3.6 | 4.0 | 4.2 |
| | 4.0 | 4.7 | 5.1 | 5.4 |
| | 5.0 | 6.9 | 7.4 | 7.8 |
| | 6.0 | 10.9 | 11.4 | 12.1 |
| | 7.0 | 18.9 | 19.3 | 20.5 |
| 85 | 3.0 | 3.0 | 3.3 | 3.1 |
| | 4.0 | 3.6 | 3.9 | 3.8 |
| | 5.0 | 4.9 | 5.1 | 5.1 |
| | 6.0 | 6.9 | 7.1 | 7.2 |
| | 7.0 | 10.2 | 10.5 | 10.3 |
| 95 | 3.0 | 2.2 | 2.2 | 2.2 |
| | 4.0 | 2.7 | 2.7 | 2.7 |
| | 5.0 | 3.5 | 3.5 | 3.5 |
| | 6.0 | 4.9 | 4.9 | 4.9 |
| | 7.0 | 7.4 | 7.4 | 7.4 |
| | 8.0 | 12.1 | 12.1 | 12.1 |

1

Clicking on **View Report** will enable the user to export the list  to Excel, Word, or a pdf file.





## 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."**

# INTRODUCTION

## Aggregate Textbook Summary Guide

| | | |
|---|---|---|
| Aggregates Defined | Section I | Definitions:<br>• Coarse and fine aggregates<br>• Natural aggregates<br>• Manufactured aggregates<br>• Synthetic aggregates<br>• Natural sands and gravel<br>• Reclaimed aggregate |
| Aggregate Sampling | Section II | How to obtain representative aggregate samples:<br>• Random or judgement samples (Sect. II)<br>• Methods; stream flow, stopped belt or stockpile (fine agg) |
| Aggregate Reduction | Section III | Reducing a field sample of aggregate to test for:<br>Correlation sieve analysis<br>Sieve analysis |
| Aggregate Source Inspection | Section IV | General discussions with diagrams about ledge control concerns such as lateral variations, faults, rolling and dipping beds, deleterious materials, etc. |
| Physical Characteristics and Various Quality Tests Performed to Determine Specification Compliance per IM 209, App. C | Section V | Section V describes most of the tests performed to determine physical properties and characteristics of aggregate. Most of the procedures are done on coarse (+4) SAMPLES SUBMITTED BY District Materials personnel.<br><br>• Segregation, degradation and contamination are defined and discussed.<br>• Moisture and specific gravity are defined and discussed. |
| Sieve Analysis | Section VI | General requirements of sieve analysis, examples and practice worksheets. |
| Reports | Reports | Examples of certified aggregate reports and scale tickets. |
| Blank Sieve Worksheets | Blank Worksheets | Blank Worksheets |

# Aggregate Textbook Summary Guide

| | | |
|---|---|---|
| Aggregates Defined | Section I | Definitions:<br>• Coarse and fine aggregates<br>• Natural aggregates<br>• Manufactured aggregates<br>• Synthetic aggregates<br>• Natural sands and gravel<br>• Reclaimed aggregate |
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| Sieve Analysis | Section VI | General requirements of sieve analysis, examples and practice worksheets. |
| Reports | Reports | Examples of certified aggregate reports and scale tickets. |
| Blank Sieve Worksheets | Blank Worksheets | Blank Worksheets |

# AGGREGATE GLOSSARY

**Abrasion –** The mechanical wearing away of aggregate particles by friction and impact.

**Absorption –** The condition when an aggregate absorbs moisture into it's pore system.

**Aggregate –** Granular construction materials composed of hard mineral particles, crushed or uncrushed, which are or can be properly sized for the use intended.

**Bed** – A layer of material that is geologically similar.

**Coarse Aggregate –** All particles which are retained on No. 4 or larger sieves.

**Combined Aggregate -** An aggregate sample consisting of both coarse and fine particles.

**Contamination** – When a foreign material is mixed with an aggregate.

**Conveyor Belt Sampling –** A method of sampling aggregate by placing a template on a stopped conveyor belt and removing the aggregate.

**Degradation** – The breakdown of an aggregate due to mishandling, or freeze/thaw cycles of material stockpiled over a winter.

**Deleterious Materials** - Materials that are damaging or harmful to the intended use.

**Dense Graded Aggregate –** Aggregates that contain a proportion of material in each particle size present so as to minimize the void spaces between particles.

**Fine Aggregate –** All particles which will pass through a No. 4 sieve, and be predominately retained on the No. 200 sieve.

**Fineness Modulus** – A calculation based on a sieve analysis test to determine the coarseness of sand. This test is also used by other states for various purposes.

**Free Moisture -** The moisture on the surface of aggregate.

**Gap Graded Aggregate –** Aggregates that contain a disproportionate amount of particles, nearly the same size, creating voids between the particles.

**Gradation –** The particle size distribution of aggregates determined by using sieves with square openings and expressed in percent retained or passing.

**Instructional Memorandum (I.M.) –** Documents published by the Iowa DOT Material's Department to explain test procedures, materials acceptance, inspection procedures and other material's specifications.

**Laboratory Qualification Program (I.M. 208) –** A program for qualification or accreditation of laboratories to comply with regulations.

**Ledge** – A group of beds at a source that are all removed together.

**Manufactured Aggregates -** Manufactured aggregates are produced by the mechanical crushing and sizing of either natural or synthetic materials.

**Maximum Aggregate Size** - The smallest sieve opening, by specification, through which the entire sample of aggregate is required to pass.

**Natural Aggregates -** Natural aggregates are all those produced from naturally occurring materials, such as sand, gravel, and limestone.

**Natural Sand and Gravels -** Those aggregates referred to as "natural sand" or natural gravel" result from the natural disintegration of rock and are produced without artificial crushing.

**Nominal Maximum Aggregate Size** - The smallest sieve opening, by specification, through which the entire sample of aggregate may pass, but may also have a portion retained on the sieve.

**Nominal Size** - Term used to indicate an approximate size, either top size of material or average size in a range.

**Non-proportioned Aggregate** – An aggregate that is produced as the finished product.

**Pit** – An excavation of sand and gravel

**Pore –** The void system of an aggregate particle.

**Proportioned Aggregate** – An aggregate that will be mixed with other aggregate materials to make the finished product.

**Pycnometer –** A one or two quart jar supplied with a gasket and conical pycnometer top used for running specific gravity and moisture tests on aggregates.

**Quality Assurance (QA) –** A specified procedure where the **agency** independently checks on the Quality Control procedures. This is often done by testing split samples to verify the contractor/producers test results, and regular visits to observe their operations.

**Quality Control (QC) –** Producer's sample and testing program to assure meeting all specification limits.

**Quarry –** An open excavation from which rock is removed for construction purposes.

**Random Sample** – A sample that is not taken because of any particular reason or notion. All material produced should have an equal chance of being tested.

**Reclaimed Aggregates -** Aggregates from reclaimed Portland Cement Concrete (PCC), salvaged Hot Mix Asphalt (HMA-referred to as Recycled Asphalt Pavement (RAP), Recycled Asphalt Shingles (RAS) Recycled Asphalt Materials (RAM-combination of RAS and RAP used in HMA) and Crushed Composite Pavement (CCP-containing both PCC and HMA) which may be produced for use in applications allowed by specification.

**Representative Sample –** A sample that is representative of the total of the material being tested.

**Sample Splitter –** A device used to reduce a field sample for testing.

**Saturated Surface Dry –** The condition of an aggregate particle containing all the moisture possible but dry on the surface.

**Segregation** – When aggregate is improperly handled and a variation of the gradation occurs. The finer material will normally congregate in the center of the pile and the larger particles will tend to roll to the outside of the pile.

**Sieve Analysis –** The separation of material based on particle size.

**Specific Gravity –** The ratio of the density of a material to the density of water.

**Specification** – A rule or limit that is to be followed when performing work for the Iowa DOT. There is a book of Highway Specifications with changes published twice a year as Supplemental Specifications.

**Stockpile Sampling –** A method of sampling fine aggregate by use of a sand probe or shovel.

**Stream Flow Sampling –** A method of sampling aggregate by intercepting the aggregate streamflow with a sampling device.

**Verification -** Agency's personal sample and testing to validate material is within specification limits.

**Zinc Chloride ($ZNCl_2$) –** A heavy liquid solution used to separate lightweight particles in aggregate samples by floatation.

## COMMONLY USED ABBREVIATIONS

**AASHTO –** American Association of State Highway and Transportation Officials
**$Al_2O_3$ –** Aluminum Oxide
**AB** – Approved Brand
**Abr.** – Abrasion
**Abs.** - Absorption
**ACI –** American Concrete Institute
**Agg. –** Aggregate
**AMC –** Area Materials Coordinator
**AS –** Approved Source
**CA –** Coarse Aggregate
**CDM** – Concrete Design Mixture
**Contr. –** Contractor
**Corr. -** Correlation
**CML –** Central Materials Laboratory
**DME –** District Materials Engineer
**DOT –** Department of Transportation
**Dur. –** Durability
**FA –** Fine Aggregate
**FM** – Fineness Modulus
**Frict. –** Friction
**F & T –** Freeze and Thaw
**HMA –** Hot Mix Asphalt
**IA –** Independent Assurance
**I.M. –** Instructional Memorandum
**Matls. –** Materials
**PCC –** Portland Cement Concrete
**PL –** Plastic Limits
**QA –** Quality Assurance
**QC –** Quality Control
**QMA** – Quality Management of Asphalt
**QMC** - Quality Management of Concrete
**RAP –** Recycled Asphalt Paving
**RCE –** Resident Construction Engineer
**SpG –** Specific Gravity
**SSD –** Saturated Surface Dry
**S & T –** Sampling and Testing
**TTCP –** Technical Training and Certification Program
**Verif. –** Verification
**Wt. -** Weight
**$ZnCl_2$ -** Zinc Chloride

**MEASUREMENTS**

**oz. -** ounce
**lb. -** pound
**T. -** Ton
**in. -** inch
**ft. –** foot
**$^2$ -** squared
**$^3$ -** cubed

## ROUNDING & DECIMALS

Rounding is uniform throughout the certification training. Look at the place to the right of the number you are rounding to and if it is 5 or above round up or 4 and below it remains the same.

Examples:

Rounding to whole numbers-
130.5 = 131 130.4 = 130 130.46 = 130

Rounding to tenths-
130.55 = 130.6 130.54 = 130.5 130.646 = 130.6

Rounding to hundredths-
130.555 = 130.56 130.544 = 130.54 130.5545 = 130.55

Rounding to thousandths-
130.5555 = 130.556 130.5544 = 130.554 130.55546 = 130.555

The following shows examples of where to round test answers:

Specific Gravity – hundredths – 2.623 = 2.62 2.768 = 2.77

Moisture – tenths – 2.67 = 2.7 0.55 = 0.6

Fineness Modulus – hundredths – 2.849 = 2.85 3.099 = 3.10

Coal, shale, clay, chert, iron – tenths - 0.56 = 0.6 0.71 = 0.7

# FORMULAS AT A GLANCE

**GRADATION CALCULATIONS; REF: IM 302;**

$$\% \text{ retained} = \frac{\text{weight retained}}{\text{original dry weight}} \times 100$$

(nearest tenth %) (ex. 1.54 = 1.5%)

**#200 DETERMINATION; REF: IM 306**

$$\% \text{ passing No. 200 sieve} = \frac{(\text{washing loss + pan weight})}{\text{original dry weight}} \times 100$$

(nearest tenth %)

**SPECIFIC GRAVITY CALCULATIONS; REF: IM 307**

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

(nearest hundredths)

P = Pyc filled with water

W = Pyc sample (SSD) & water

**% FREE MOISTURE/ABSORPTION; REF: IM 308**

**Moisture table IM T215A**

(nearest tenth %)

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

$W - W_1$ = grams (read table under sample size 1000 grams or 2000 grams)

W = pyc jar; (sample (SSD) & water)

$W_1$ = pyc jar; (wet sample from stockpile & water )

$G_s$ = Specific Gravity of material in a saturated-surface-dry condition

s = Weight in grams of wet sample

**% SHALE REF: IM 344 & 345**

(nearest tenth %)

$$\% \text{ shale} = \frac{\text{washed decanted particles of shale}}{\text{original dry weight of sample}} \times 100$$

**% CLAY LUMPS & FRIABLE PARTICLES REF: IM 368**

$$\% P = \frac{(W\text{-}R)}{W} \times 100$$

(nearest tenth %)

P = % clay lumps

W = dry weight + (#4 sample)

R = dry weight + (#8 material after removal of clay lumps)

**FINENESS MODULUS REF; IM 302**

(nearest hundredth)

FROM CONCRETE SAND GRADATION WORKSHEET

% retained on 3/8 thru No. 100 added cumulatively;

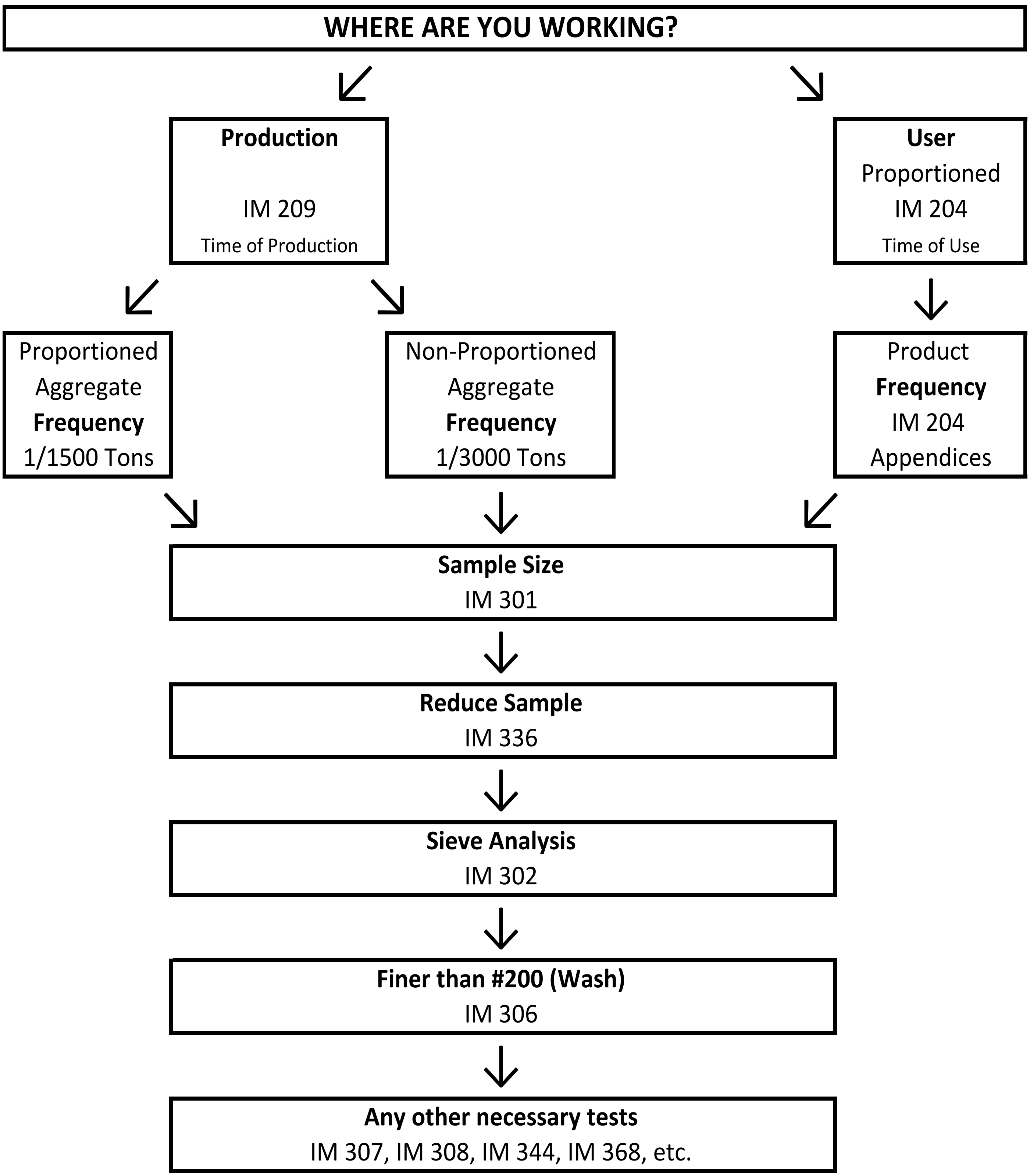
No. 4 = 3.6 % retained = 3.6

No. 8 = 19.1 % retained (3.6 + 19.1) = 22.7

Total cumulative % = (Add the last column starting with 3.6 + 22.7 thru No. 100)

Total cumulative % retained / 100 = Fineness Modulus

# AGGREGATE SIEVE ANALYSIS



# FORMULAS AT A GLANCE

**GRADATION CALCULATIONS; REF: IM 302;**

$$\% \text{ retained} = \frac{\text{weight retained}}{\text{original dry weight}} \times 100$$

(nearest tenth %) (ex. 1.54 = 1.5%)

**#200 DETERMINATION; REF: IM 306**

$$\% \text{ passing No. 200 sieve} = \frac{(\text{washing loss} + \text{pan weight})}{\text{original dry weight}} \times 100$$

(nearest tenth %)

**SPECIFIC GRAVITY CALCULATIONS; REF: IM 307**

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

(nearest hundredths)

P = Pyc filled with water
W = Pyc sample (SSD) & water

**% FREE MOISTURE/ABSORPTION; REF: IM 308**
**Moisture table IM T215A**
(nearest tenth %)

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

$W - W_1$ = grams (read table under sample size 1000 grams or 2000 grams)
W = pyc jar; (sample (SSD) & water)
$W_1$ = pyc jar; (wet sample from stockpile & water )
$G_s$ = Specific Gravity of material in a saturated-surface-dry condition
s = Weight in grams of wet sample

**% SHALE REF: IM 344 & 345**
(nearest tenth %)

$$\% \text{ shale} = \frac{\text{washed decanted particles of shale}}{\text{original dry weight of sample}} \times 100$$

**% CLAY LUMPS & FRIABLE PARTICLES REF: IM 368**

$$\% P = \frac{(W-R)}{W} \times 100$$

(nearest tenth %)

P = % clay lumps
W = dry weight + (#4 sample)
R = dry weight + (#8 material after removal of clay lumps)

**FINENESS MODULUS REF; IM 302**
(nearest hundredth)
FROM CONCRETE SAND GRADATION WORKSHEET
% retained on 3/8 thru No. 100 added cumulatively;
No. 4 = 3.6 % retained = 3.6
No. 8 = 19.1 % retained (3.6 + 19.1) = 22.7

Total cumulative % = (Add the last column starting with 3.6 + 22.7 thru No. 100)
Total cumulative % retained / 100 = Fineness Modulus

## AGGREGATE SIEVE ANALYSIS

**WHERE ARE YOU WORKING?**

**Production**
IM 209
Time of Production

**User**
Proportioned
IM 204
Time of Use

Proportioned
Aggregate
**Frequency**
1/1500 Tons

Non-Proportioned
Aggregate
**Frequency**
1/3000 Tons

Product
**Frequency**
IM 204
Appendices

**Sample Size**
IM 301

**Reduce Sample**
IM 336

**Sieve Analysis**
IM 302

**Finer than #200 (Wash)**
IM 306

**Any other necessary tests**
IM 307, IM 308, IM 344, IM 368, etc.

# SECTION I
# AGGREGATES

## SECTION I
## AGGREGATE

Today's highways must have the strength and durability to sustain high volumes of traffic for many years. Since pavements and base courses of these highways are composed largely of aggregates, these materials must be of a quality level that will permit satisfactory performance. Consequently, the role of the aggregate inspector is vital to securing good highway performance. Design and construction techniques can never satisfactorily compensate for the use of substandard aggregates. A well-designed and constructed highway using good aggregates will provide good service for many years. A well-designed and constructed highway using substandard aggregates will soon become a maintenance problem. This section contains general information on aggregates and the tests used to control their quality. Those aggregates commonly produced and used in Iowa will be emphasized, as will the tests that have been determined through experience to be the best measure of their quality.

Iowa requires aggregate for use on administered projects to be certified by producers/suppliers on the Approved Aggregate Producers list, Materials Instructional Memorandum (I.M.) 209, App. B.

*Aggregates are often referred to as rock, gravel, mineral, crushed stone, slag, sand, rock dust, or fly ash.*

### AGGREGATES DEFINED

Generally, aggregates are granular construction materials composed of hard mineral particles, screened or crushed, which are or can be properly sized for the use intended. Glacial clay is composed of minute granular mineral. However, the term "aggregate" as used in this booklet will be referring to granular materials that contain, at most, only a few percent of particles that will pass through a No. 200 sieve.

Reclaimed Asphalt and Portland Cement Concrete may also be recycled into usable aggregate products by milling or crushing, and properly sized to meet specified requirements.

**Aggregate Classification**

**Coarse Aggregate: Any aggregate that is retained on the No. 4 sieve.**

**Fine Aggregate: Any aggregate that passes the No. 4 sieve.**

## Coarse and Fine Aggregates

Aggregates are frequently referred to as “fine” or “coarse.” There is no universally accepted particle size that separates fine aggregate from coarse aggregate. We have chosen the No. 4 sieve as the sieve size with which to make this separation for quality or physical characteristics tests. All particles which will pass through a No. 4 sieve, and be predominately retained on the No. 200 sieve, are referred to as “fine aggregates.” All particles which are retained on No. 4 or larger sieves are referred to as “coarse aggregate.”

## Natural Aggregates

Natural aggregates are all those produced from naturally occurring materials, such as sand, gravel, limestone, etc., which can be modified by crushing, washing, or screening as necessary for the use intended.

## Synthetic Aggregates

Synthetic aggregates are all those produced from materials that have been mineralogically altered by artificial means. Expanded shales and clays (lightweight aggregate), fly ash, slag, etc., are examples of synthetic aggregates.

## Manufactured Aggregates

Manufactured aggregates are produced by the mechanical crushing and sizing of either natural or synthetic materials. Manufactured sand, for instance, could be made by crushing and sizing either a natural material such as limestone or synthetic material such as slag. However, even though a manufactured sand can be a natural aggregate, it cannot be a natural sand. The reason for this is explained in the next paragraph.

## Natural Sands and Gravels

Those aggregates referred to as “natural sand” or “natural gravel” result from the natural disintegration of rock and are produced without artificial crushing. They can, however, be washed or mechanically sized.

Thus, the term “natural” is used in two different ways. There are natural aggregates as opposed to synthetic aggregates and natural sands as opposed to manufactured sands. Consequently, sand made by crushing quartzite or limestone is a natural aggregate but not a natural sand.

## Reclaimed Aggregates
## (IM 209 and IM 210)

Aggregates from reclaimed Portland Cement Concrete (PCC), salvaged Hot Mix Asphalt (HMA-referred to as Recycled Asphalt Pavement (RAP), Recycled Asphalt Shingles (RAS), Recycled Asphalt Materials (RAM-combination of RAS and RAP used in HMA) and Crushed Composite Pavement (CCP-containing both PCC and HMA) may be produced for use in applications allowed by specification.

Quality control during salvaging operations, processing, and use of these reclaimed materials is essential.

## Aggregate Uses

Aggregates are used in portland cement concrete, asphaltic concrete, bases, subbases, granular backfills, revetment, etc.  A summary of the quality and gradation specifications for the construction aggregates are listed in Division 41, Construction Materials of the Standard Specifications.

# SECTION II
# SAMPLING

# SECTION II
# SAMPLING METHODS AND EQUIPMENT

## Introduction

This chapter deals with the different sampling methods and equipment. Before beginning to study, be sure to have a copy of the current Aggregate Reference Manual prepared by the Technical Training and Certification Program staff.

## Importance of Proper Sampling

**No other single phase of an Aggregate Inspector's duties is as important as obtaining a representative sample.** At this point, all of the money and time which will be expended on the remaining activities of testing and evaluating may be lost or rendered useless by an improper sampling technique on the part of the Aggregate Inspector. In other words, if the sample you take is not representative of the total material, it is absolutely impossible to end up with a test result that means anything. At the completion of instruction you must know how to obtain a proper sample. Without this knowledge, it is useless to proceed further into the areas of test procedure.

*No other single phase of an Aggregate Inspector's duties is as important as obtaining a representative sample.*

## Sampling Frequency

Minimum sampling and testing frequencies required at the **time of aggregate production** are listed in I.M. 209. The required minimum aggregate sampling and testing frequencies of aggregates at **time of use** (proportioned aggregate) are listed in the appendices of I.M. 204. Sampling frequencies referenced are minimums and may need to be increased for reasons such as low or intermittent production and widely varying or noncomplying test results.

## Size of Sample

Refer to Materials I.M. 301 in the Field Testing Manual. Appropriate minimum aggregate sample sizes for the determination of sieve analysis are listed on page 4 of this I.M. The sample sizes are based on the maximum particle size in the finished products.

## Random Sampling

The sample must be representative of the total of the material being tested. This is normally accomplished by random sampling. The random sample should not be obtained because of any particular reason or notion. All aggregate being produced or used should have an equal chance of being tested. The inspector should not determine when or what to sample by judging if the material looks good, bad, or average, because that represents a judgement sample and not a random sample. Random samples are taken when the plant is operating at the usual rate for that plant.

It must be pointed out that not all test samples are random samples. Normally they will be the same, but there will be times when the inspector must choose the time of sampling such as new hammers placed on the secondary crusher, an area of clay in the quarry, or fine sand seams in a gravel pit. These things will directly affect gradation of the material and must be checked immediately to keep the material within proper limits. During a normal day's operation, all samples taken and tested may be random samples if all operations are running consistently. Some days will have no random samples taken, such as the first days to establish crusher settings, etc. Some days will have a combination of random and check samples. Keep in mind that during normal, steady production the samples should be taken on a random basis to represent the total of the material being produced.

## Location for Sampling

To help assure that representative samples are taken, one of the following methods will be used for obtaining aggregate samples: 1) obtaining a portion of the material carried on a conveyor belt, 2) intercept the complete material streamflow from the end of a conveyor belt or from overhead bin discharge, 3) sampling from the production stockpile (only for fine aggregate or as directed by the District Materials Engineer). The preferred method of coarse aggregate sampling is the streamflow method.

Whichever sampling method is used, at least three separate increments must be taken for each field sample. Obtaining more than three increments, when possible, will better represent the material being tested by providing a wider cross-section of the product.

The field sample must also meet the minimum weight requirement as listed in I.M. 301 for the product being tested.

## Conveyor Belt Sampling

To obtain an off-the-belt sample, stop the belt, insert a template, remove all material within the template, and combine it into the field sample. A minimum of three locations is required when obtaining a sample using this method. Normally, the belt should be recharged for each location to help assure a representative sample. In belt sampling, the ends of the template should be spaced just far enough apart to get an increment that weighs approximately one-third the minimum weight of the field sample. If the template does not yield the minimum size of field sample in three locations, additional locations will be necessary. No less than three separate locations should be used in obtaining one field sample.

*Sampling from a conveyor belt using a template*

## Streamflow Sampling

When obtaining the field sample by intercepting the aggregate streamflow, care must be exercised so that the sampling device passes quickly through the entire streamflow and does not overflow. At least three separate passes shall be made with the sampling device when obtaining a field sample. Each pass is an increment of the field sample.

*Streamflow Sampling*

## Stockpile Sampling

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 at different locations around the pile shall be taken. Care should be used to not sample at the bottom of the stockpile.

Stockpile sampling of coarse or combined aggregate should be avoided. If it becomes absolutely necessary to obtain a sample from a stockpile, consult the District Materials Engineer to help you devise an adequate sampling plan.

*Stockpile sampling using a shovel.*

*Stockpile sampling using a sand probe.*

## Sampling Stockpiles for Gradation Confirmation

Stockpile sampling of coarse or mixed coarse and fine aggregate is difficult due to segregation. When sampling to determine gradation compliance of these materials, the Contractor, Producer or Supplier will supply equipment such as a sampling bin or flow-boy to provide a streamflow or stopped conveyor belt sampling location.

An end-loader will open the pile to be sampled in at least three locations. One end-loader bucket from each opened area is then placed into the sampling bin and sampled in a manner to assure representation of the entire quantity.

Alternately, material from each of the opened areas may be combined in a small stockpile, carefully blended to minimize degradation of the aggregate, and placed into the sampling bin.

Avoid obtaining sample increments at the beginning or end of bin discharge due to the natural tendency of segregation through the bin.

*It is not always easy to get a proper sample, but it is very important to use all the care you can. Always remember, if your sample is not representative, your test results are not worth the paper they are written on.*

## Sampling Records

It is the responsibility of the aggregate sampler to get all the necessary information to fill out report headings. This may include type of material, intended use, sample location, T-203 A number, project number (if one is available), contractor who will be receiving the material, and other general information. The information on the source itself should include section of the quarry or pit and the bed numbers (quarries) or working depths (pit). If special processing equipment is used, it should be noted on the reports.

Samples are taken for either 1) field testing or 2) Central Laboratory testing. Those samples which are forwarded to the Central Laboratory of the Iowa DOT should be placed in a standard canvas sack and securely tied to prevent loss of material during shipping. An identification form should be filled out completely and placed inside the sample sack. Other identification tags should be attached to the tie for shipping information.

*No less than three separate locations or passes should be used in obtaining one field sample.*

## Mechanical Samplers

Mechanical or industrial samplers are used to extract samples from many kinds of free-flowing materials. While there are many different sampler designs, they basically function in the same fashion as the methods described above. The design and operation of the sampler eliminates issues inherent with hand sampling methods, especially if the production plant is capable of producing a large volume of material. Mechanical samplers can be installed in chutes or at the end and middle of moving belts. Not only do they facilitate collecting representative samples, they increase the level of safety by minimizing exposure to moving components of the stream flow. The practice of collecting production over a sufficient time to produce a representative sample should also be applied to mechanical samplers. If the mechanical sampling system produces a very large sample, use the reduction methods described in Materials IM 336 or continue correlations until a minimum time period can be established.

If a mechanical sampler is newly installed, the sampler gradation should be compared to a manually collected sample with acceptability being IM 216 tolerances. Sampling should be done in collaboration with the production plant personnel. If stop-belt sampling is used for the comparison, controls for the belt will need to be “locked out” by the Producer for both safety and to meet MSHA requirements.

## Review

**Before you start out to take a sample, you should ask yourself these questions:**

1. Are you sure that your plan for getting the sample is complete?
2. Have you checked on the approved method of taking the sample?
3. Do you know the weight of sample that is required?
4. Do you have the proper tools?
5. Do you have clean containers at hand for the sample?

**After you have obtained the sample, you should ask yourself these questions:**

1. Are you sure the sample really represents the material?
2. Should you divide the sample and retain part of it?
3. Is the sample completely identified?
4. Does your record show the nature of the material, its intended use, and exactly when, where, and how the sample was taken?

# SECTION III
# REDUCTION

## SECTION III
# FIELD SAMPLE REDUCTION
## FOR HMA/PCC VERIFICATION SAMPLES

### Introduction

Normally, aggregate field samples need to be downsized to perform the required tests such as sieve analysis and various quality testing. The sampling technician may also need to reduce samples into equal halves for correlation testing. Correlation testing is done between two technicians using separate testing equipment. This chapter, along with Materials I.M. 336, will discuss the approved sample reduction methods.

### Importance of Sample Reduction

The technician reducing a field sample of aggregate must keep in mind the ultimate goal; the end result should be a smaller sample with the same characteristics of the original field sample.

Sample reduction should be regarded in the same way as obtaining the original field sample. The resulting smaller samples should be random, representative and the end result of the reduction process.

### Size of Sample

Sample sizes are normally determined based on the largest particle sizes represented in the product. The required sample size is also dependent on the test to be performed.

Field and test sample sizes to determine a sieve analysis are detailed in Materials IM 301.

## Methods

**Splitting:**
Fine, coarse or combined fine and coarse aggregate samples may be reduced using a riffle chute splitter. The material must be in an air dry condition, with basically no visible free moisture on the particle surfaces. The material should be dry enough to allow the aggregate to flow freely through the splitter chutes

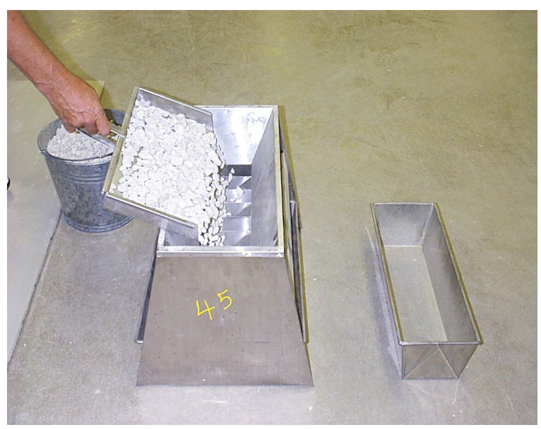
**Note:** A preliminary reduction of fine aggregate in a damp condition may be made using the 2 – inch riffle chute splitter. The resultant sample size shall be not less than 5,000 grams.

Aggregate samples with particles larger than ¾ inch should be reduced through a riffle chute splitter with 2 inch openings. When the largest particles are ¾ inch and smaller, the 1 inch splitter is preferred.


*Riffle Chute splitter*

The sample needs to be well-blended, placed in an appropriate sized pan no wider than the width of the row of chutes in the splitter, and poured across the center of the chutes in a manner to allow free-flow of the aggregate. 'Dumping' of the aggregate into the splitter tends to cause segregation of the material, resulting in inaccurate and non-correlating test results.

The entire field sample must be reduced, resulting in two approximately equal increments.




*Splitting the sample*

**Quartering:**
The preferred method of reducing a fine aggregate field sample into approximately equal halves is the Quartering method. The aggregate must be damp enough to stand in a vertical face.

The field sample of damp, fine aggregate is placed on a flat, non-absorbent surface, thoroughly mixed and flattened to an approximate 2 – 3 inch depth. Using a 'quartering device' or straight edge of appropriate size, quarter the flattened pile of fine aggregate into approximately equal quarters.

When reducing the sample into halves, the diagonal quarters are selected for each half, being sure to include all fine material.

This method may also be used to reduce a field sample to test sample size by continuing to reduce diagonal quarters until the desired sample size is achieved.

**Note:** The Quartering method should be avoided when reducing coarse or combined aggregates due to segregation problems.

*Quartering using straight edge.*

*Select diagonal quarters.*

# SECTION IV
# SOURCE INSPECTION

Section IV

# *Aggregate Source Inspection*

Aggregate source inspection involves monitoring the quality of material during the production process.  Aggregate quality is determined by a number of factors including: clay content, freeze thaw durability, consistency in specific gravity among other properties depending on the product.  Typically, preliminary testing is done by blockstoning individual beds, or obtaining samples of processed aggregate to establish the source quality potential.  Portland Cement Concrete (PCC) and revetment aggregate sources must have a written source approval before production of certified aggregate.  In any case, the producer must assure the aggregate meets minimum quality requirements before delivery to the project.

It is important for the aggregate technician to become familiar with the source.  The technician should be able to recognize significant changes that may occur in a quarry ledge or gravel deposit that could affect the quality of the intended product.  Changes in a source should be recognized through two equally important activities: 1) monitoring quality by looking for changes in test results, and 2) routine inspection of quarry ledges and underground mine horizons, looking for changes in the quarry beds, quarry ledge, or mine horizon.

The factors causing changes are different in quarries than in sand and gravel pits, and each will be covered separately.

*Quarry - An open excavation from which rock is removed for construction purposes.*

## Quarries and Mines

There are many reasons why an aggregate from a particular quarry can test differently with respect to quality than that previously produced.  Most of these reasons fall into the following categories.

a) Ledge Control: The quarry ledge has not been maintained in the same beds.

b) Lateral Variations: One or more beds in the quarry ledge have changed laterally in quality.

c) Faulted and Dipping Beds: The beds are offset along a fault or have such an irregular surface that the quarrying operation cuts across beds to the extent that the same beds are not always being worked.

d) Deleterious Materials: The quarry ledge has become intruded with pockets or seams of clay and associated weathered material.

e) Production Changes: Production methods have changed to the extent that a similar product is not being obtained.

## Ledge Control

Geologic sections have been developed for most quarries as an aid in identifying the various beds and/or quality units (Figure 3.1). The various beds are identified by a number and a description. The geologic age of the source is also noted and the relative position of the source, age-wise, can be found on a time chart such as Figure 3.2. Every layer or bed of rock in a quarry can be quite different in quality while often times quite similar visibly. Consequently, when material is being produced on the basis of previously established quality, we must be sure that the quarry ledge is in the same beds as used before, or within the approved beds in the case of use for asphalt (HMA) to PCC and revetment since HMA aggregate ledges need to be “pre-approved” for quality and Friction type. If the producer is not, contact Geology Section of the Central Materials Lab and they will help re-establish the ledge or determine if the new beds in


*Bedding planes in an underground quarry.*

the ledge are of a quality that will assure specification compliance of the final product. In quarries where bedding planes are distinct and continuous, it is easier for the producer to maintain a ledge in the same beds and for the inspector to ascertain which beds they are. When there are no good bedding planes, the producer can have difficulty remaining in the same beds and difficulty knowing exactly which beds are being worked. The quarry floor may need to be raised or lowered to maintain ledge control. Satisfactory ledge control can be maintained by applying the answers to the following questions to the source being used.

Do specifications or special provisions require ledge control?  Some materials do, such as coarse aggregate for Portland cement concrete and revetment stones.

Does the production history indicate that the finished product will be borderline on quality or well within the requirements?

What is the quality level of the beds that might be added to the ledge?

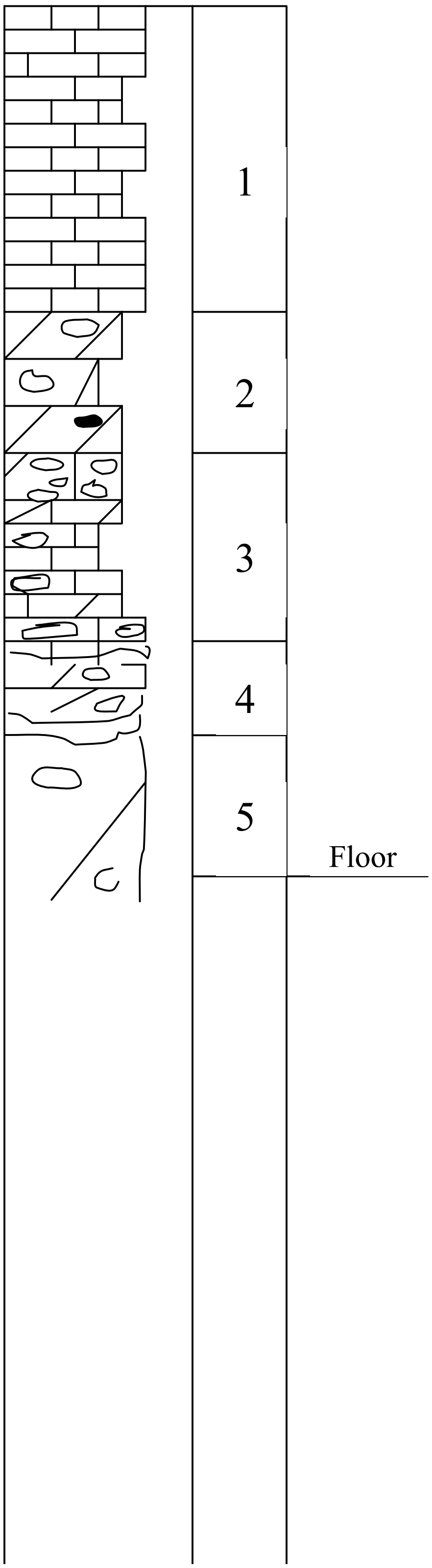
Could additional beds improve a borderline product or cause it to fail?

Could the additional beds be of such poor quality that they should not be incorporated into the manufacture of any product?

Often, all that is necessary is a proper identification of the ledge being worked so as to compile a dependable production history for the source.  When in doubt, always consult the appropriate supervisor.

**SW¼ Sec. 23 T. 95 R. 15 Co. Floyd**

| | |
|---|---|
| **Peterson 5/6/75** | **Carville Quarry** |
| | **Heckman-Reynolds** |
| | |




00: Overburden ± 3.0’

CEDAR VALLEY FORMATION
(Coralville Member)

1. Limestone; light brown; medium crystalline; very petroliferous; carbonaceous laminations; thin to platy bedding. ±6.

2. Dolomite; light brown; coarse crystalline; a few small calcite-filled vugs- as 3 or 4 beds; very hard. 2.

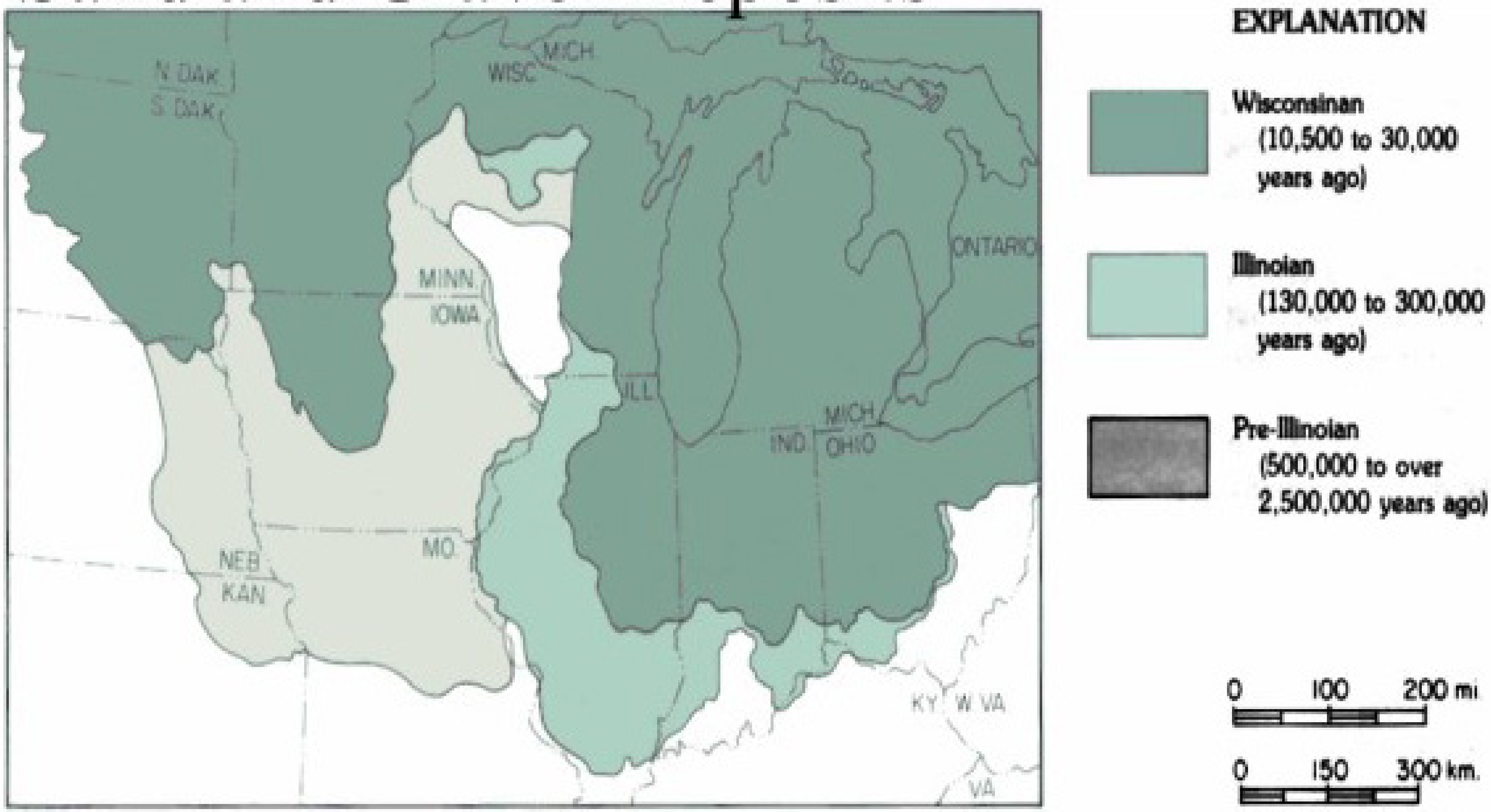
3. Limestone; light, pinkish gray; medium crystalline; dolomitic; many large calcite-filled vugs in zones parallel to bedding; flaggy beds 0.3 - 0.6’ thick; upper 1.0’ is a distinctive zone of highly concentrated calcite-filled vugs. ±4.

4. Dolomite; light pinkish gray; fine crystalline; many calcite-filled vugs and “birdseye” calcite; a few small pelecypod fragments; as 3 or 4 wavy beds; reddish brown shale parting at the base; irregular reddish brown shaley bed 0.2’ thick at top; hard. ±1.

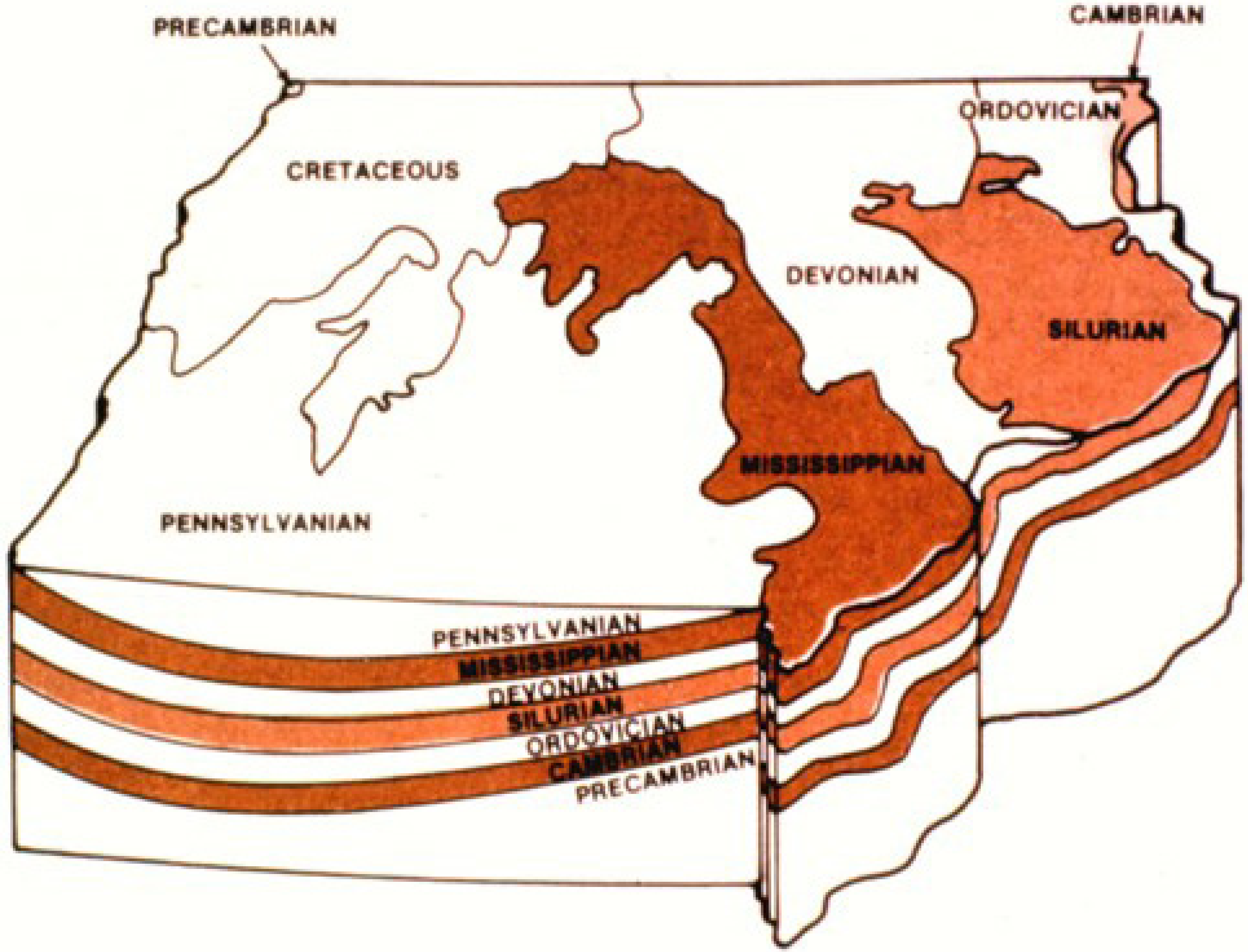
5. Dolomite; light, pinkish gray; medium crystalline; has a few small calcite-filled vugs and “birds-eye” calcite; massive but fractured; hard. ±3.

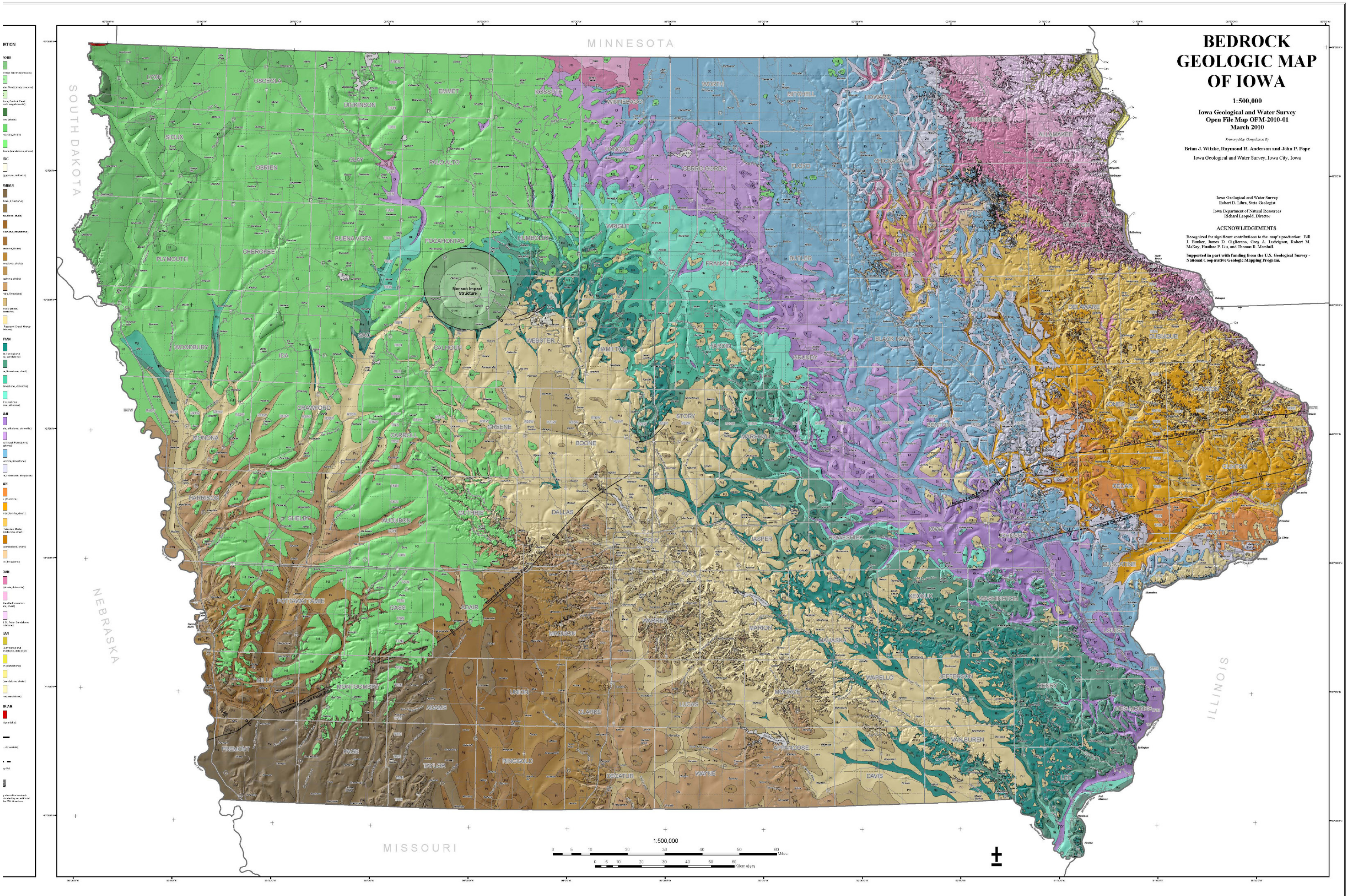
FIGURE 3.1

# Glaciers brought Canadian rocks to form Sand and Gravel Deposits




Limits of Major Glacial Advances in the Upper Midwest


PRECAMBRIAN
CAMBRIAN
ORDOVICIAN
CRETACEOUS
DEVONIAN
SILURIAN
MISSISSIPPIAN
PENNSYLVANIAN
PENNSYLVANIAN
MISSISSIPPIAN
DEVONIAN
SILURIAN
ORDOVICIAN
CAMBRIAN
PRECAMBRIAN



BEDROCK GEOLOGIC MAP OF IOWA
1:500,000
Iowa Geological and Water Survey
Open File Map OFM-2010-01
March 2010
Primary Map Compilation By
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MINNESOTA
SOUTH DAKOTA
NEBRASKA
MISSOURI
ILLINOIS
Manson Impact Structure
1:500,000
Miles
Kilometers

## Lateral Variations

Lateral variations in bed quality may be caused by the effects of weathering. Other lateral variations are due to the factors of deposition which were present when the bed was formed. Some geologic units characteristically show very little lateral variation (like the Galena Group), others show a lot (like the St. Louis Formation). Lateral variations may or may not affect the quality of the bed. Each case has to be evaluated individually.

Variations in quality can be caused by actual compositional changes in a bed or by changes in thickness. A 0.2 ft. thick shale bed may increase to a very troublesome 1 ft. or more in thickness, requiring benching and removal (Figure 4.1). A limestone or dolomite bed may suddenly pinch out, becoming replaced by sandstone or some other type of rock. This happens frequently in the formations common in southeastern Iowa, but not too often elsewhere.

More common are compositional changes characteristic of those geologic formations which contain breccias which are angular fragments of rock in generally shaly matrices (Figure 4.2). Breccia thickness can vary considerably within the same quarry, often affecting beds in the adjacent quarry ledges. At other times, beds will gradually change in composition, may increase in shale, become sandy, etc. Either type of change can affect the quality of the rock.

An inspector must learn and be alert to any changes that can occur that will affect the quality of the finished product.

## Faulted and Dipping Beds

Frequently, the quarry beds are not flat lying. They may dip at a uniform angle (Figure 5.1), or they may roll up and down from 1 ft. to 2 ft. to commonly as much as 8 ft. over a lateral distance of 100 ft. (Figure 5.2). When either situation occurs, a flat lying quarry floor will cut across beds that may not be of the quality level required for the aggregate product becoming being made. Proper ledge control might require that a quarry floor be raised, lowered, or worked at an angle in order to insure the production of complying material.

True faults, fractures in bedded rock accompanied by differential movement in the fault zone, are not common, but there are a few. A quarry ledge crossing a fault will suddenly be working different beds depending on the amount of movement that occurred along the fault (Figure 5.3). This can be a problem depending on the nature of new beds incorporated into the ledge. Often, large blocks will exhibit minor slippage along the vertical joints and appear as small faults in a quarry face. These are the most common in the Galena Group and Cedar Valley Formation, both of which have massive rock units with well developed joint systems.

*Picture 4.1 - Changing bed thickness*

*Picture 4.2 - Breccia*

*Picture 5.1 - Dipping beds*


*Picture 5.2 - Rolling beds*

*Picture 5.3 - Fault*

*Picture 5.4 - Karst*

*Picture 6.1 - Void spaces in rock*

*Picture 6.2 - Clay pockets*

## Deleterious Materials

Ground water moving along vertical joints and horizontal bedding planes commonly leaves large void spaces in the rock (Karsts - Figure 5.4). These are frequently filled with clay or other materials that were available to the moving ground water (Figure 6.1). Occasionally, so much foreign material will be in the rock that it cannot be used for aggregate purposes. Rocks can become contaminated with clay or shale during deposition. This is the case with the Silurian reefs found in eastern Iowa. Ordinarily, the rock is of high quality, but clay pockets can become very troublesome (Figure 6.2). The clay content of aggregate being produced from this type of rock should be monitored closely when there are limits placed on clay lumps, clay balls, etc.

## Production Changes

Some products can be made at certain quarries only by beneficiating or treating the material in order to improve its properties during the manufacturing process. For instance, when a quarry ledge consists of beds with argillaceous (clay) partings on the bedding planes, the removing or scalping of the minus 3/4 in. from the primary crusher may remove enough of this material to substantially improve the soundness of the final product. These situations should be documented in the source files, so that any future production employs equal or better methods of product beneficiation or improvement.

## Sand and Gravel Pits

Sand and gravel pits are granular deposits located in areas where moving water has concentrated the sand and gravel-size particles in sufficient quantity. They are generally in or adjacent to the many streams and rivers in Iowa or in glacial outwash deposits where the melting ice generated the water flow necessary to form sand and gravel deposits. There are many factors, which can cause quality changes in sand and gravel pits, but only the main points will be covered.

***Sand*** *- Granular material almost entirely passing the No. 4 sieve and predominantly retained on the No. 200 sieve.*

***Gravel Pit Face:*** *Note how the gravel is deposited in layers of coarse and fine aggregate while some areas may contain shale or clay. It is important for the producer to process this type of source properly to maintain consistent quality and gradation (i.e. using a dozer to work the entire exposed face to blend the material before it is processed at the plant.*

Flowing water deposits material only in relation to the load it carries (always changing) and its velocity and direction. Most deposits are accumulations over long time periods under a variety of conditions. Consequently, the deposit can be alternately coarse or fine, dirty or clean. Thus a greater degree of dependence is placed on the production methods and equipment to give a uniform quality product than in the case of crushed stone.

Any change in production equipment or methods, in the area or depth of working, or in the appearance of the product should be noted since any one could signal a changed quality level in the final product. Gravel coarse aggregate may perform to different degrees in pavement because, despite containing relatively high percentages of extremely durable igneous materials, they may also contain significant percentages of good to poor quality limestone, and of course, the chert, iron spalls, shale particles, and other objectionable materials that frequently cause gravel pavements to have a poor appearance. Held within the specified limits, the objectionable materials will not affect the durability of pavement.

The quality of the limestone fraction, however, can affect the durability of pavement. When necessary, gravel coarse aggregates can be separated and tested according to rock type using a modification of the ASTM Standard Recommended Practice for Petrographic Examination of Aggregates for Concrete. To determine the Durability Class of a gravel, the carbonate (limestone or dolomite) fraction is separated from the gravel and analyzed to determine the pore system of the carbonate rock and the susceptibility of this rock to deterioration due to the use of deicing salts.

# SECTION V
# PROPERTIES

# SECTION V
# AGGREGATE PROPERTIES AND CHARACTERISTICS

Ideally, construction aggregates should be composed of durable, abrasion-resistant particles free of any deleterious or objectionable materials such as clay, shale, coal, organic matter, etc. Their specific gravities and absorptions are important when they are incorporated into Portland cement or asphaltic concrete mixes.

## Aggregate Production Problems

Three common problems occur during the production phase and also at the time of use. These are SEGREGATION, DEGRADATION, and CONTAMINATION. When any of these conditions occur, it will affect the performance of the aggregate for its intended use and may lessen the design life of the project.

*Segregation in a stockpile*

Segregation will occur anytime an aggregate is handled, and is especially predominate during construction of the stockpile. When a stacker conveyor is used, the finer (smaller) material will normally congregate in the center of the pile. The larger particles will tend to roll to the outside of the pile. As material is fed out of the stockpile, gradation variation is likely to occur.

When using a stacker conveyor, a helpful technique is using a movable stacker capable of building the stockpile in lifts.  If the stacker is set too high, segregation will still occur.  Some materials, such as “recycled asphalt paving” (RAP), have specifications controlling the height of individual lifts during stockpile construction.


*Stacking using a stacker conveyor*

Truck dumping is another common method of stockpile construction.  With some less critical aggregates, this is usually accomplished with trucks running on the stockpile to make additional lifts.  This method can result in degradation (breakdown) of the material as the trucks drive across the stockpile.  Also, as the height of the stockpile increases, aggregate dumped close to the edge will segregate, with the coarser material rolling down the outside of the stockpile.  Multiple lift truck stockpile construction of more critical aggregates, such as aggregate intended for use in paving, should be avoided.

Using a dozer to construct a stockpile is not recommended, especially with an aggregate prone to degradation.  When a dozer is used, it normally forms ramp areas that are used over and over, tending to grind the aggregate under the tracks.

When loading material from a stockpile using an end loader, it is best to work along the entire vertical face of the pile.  Done properly, this tends to equalize the coarse and fine areas of the stockpile, minimizing the segregation.

Contamination can easily happen during stockpiling.  Material of one type may mistakenly be dumped into the wrong stockpile, contaminating both products.  Different materials stockpiled too close to each other tends to lead to contamination where the stockpiles adjoin.  Stockpiles should be constructed on sound bases to help eliminate contamination during the load-out process.  Sometimes loader operators get too low when loading-out, or the bases may soften during the spring thaw or wet periods, increasing the danger of contamination from mud or dirt.

A good inspector should be alert to segregation, degradation and contamination and take steps to correct the problem before the effected material can be incorporated into the project.

## Deleterious Material

It is very important that the aggregate be kept clean and free from deleterious substances. For this reason, the specifications limit the amount of deleterious substances that can be present. Shale, coal, chert, and other lightweight particles tend to float in a PC concrete mix.

## Resistance to Abrasion

Abrasion is the mechanical wearing away of aggregate particles by friction and impact. Aggregates with low resistance to abrasion will readily wear away when used as surfacing materials or when exposed in pavement surfaces. They also degrade with handling. Excessive handling of aggregates with low resistance to abrasion can result in their containing relatively high percentages of fine material, often above the maximum level specified for the No. 200 sieve for the particle aggregate involved.

*Los Angeles Abrasion test machine*

## Los Angeles Abrasion Test

Resistance to abrasion is determined by the use of the Los Angeles Abrasion Machine, a cylindrical drum mounted on a horizontal shaft. A specified weight of coarse aggregate is placed in the machine along with a specified number of standard steel balls, the abrasive charge. After rotation at 30-33 rpm for 500 revolutions, the percentage of the aggregate sample that has been abraded to pass No. 12 sieve is reported as the loss due to abrasion, the percentage of wear.

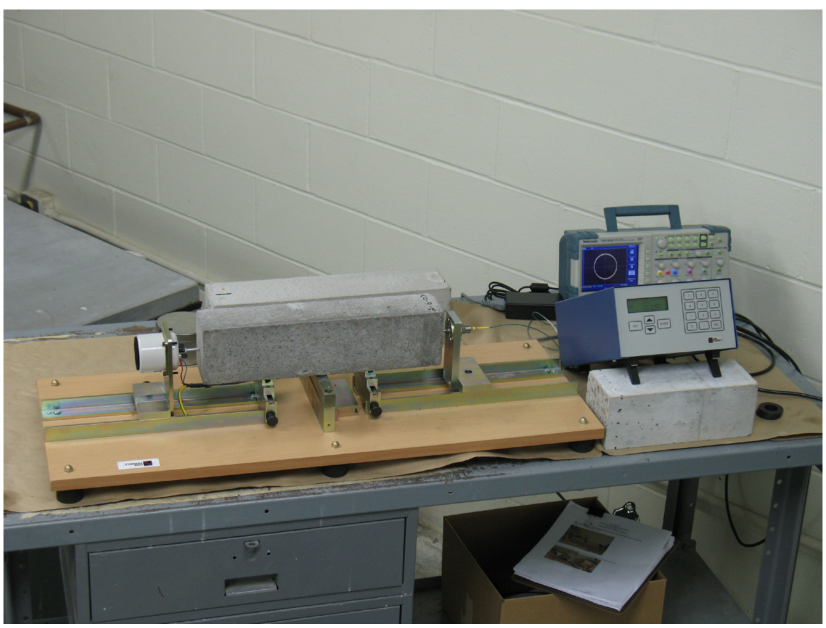
Natural gravels will generally develop wear losses of 20% to 35% when tested for abrasion resistance.  Crushed limestone aggregates will generally develop wear losses of 30% to 45%.  Losses of 45% or more are commonly accepted to be indicative of aggregates with poor resistance to abrasion.

## Durability and Soundness

These two terms are very similar in meaning and are often used interchangeably. The durability of an aggregate or other material is a measure of its ability to perform satisfactorily over an extended period of time.  Soundness of an aggregate is a measure of its ability to resist the detrimental effects of exposure to natural forces.

### Durability

Aggregate related deterioration can lead to the premature failure of our Portland Cement Concrete (PCC) highways.  Durability is done only for coarse aggregate for use in PCC.  The designations of Class 2, Class 3, and Class 3i durability are used.  The best method to determine durability class is to observe the performance of a concrete pavement that was constructed with the coarse aggregate in question.  If the pavement has performed satisfactorily for 20 years, it is a Class 3 durability.  Class 3i durability aggregates must perform satisfactorily at least 35 years in interstate class highways.



*Durability Test-Sound wave machine with prepared samples (concrete cubes with brass plugs on each end).  Sound wave is transmitted through each cube before subjecting the sample to 300 F&T cycles and that reading is compared to first reading.  If the coarse aggregate used in the sample tends to be susceptible it will crack during the process and the second sound wave will indicate how much aggregate was affected.*

When a pavement performance history is not available, we have relied on ASTM Designation C666, Method B to make laboratory determination of the durability class. This consists of a series of 300 freeze and thaw test cycles on a concrete specimen and takes approximately 6 months to complete.

Much of an aggregate's ability to perform in PCC is a function of the pore spaces between the mineral grains. These voids can be thought of as both large pores connected to a smaller, or capillary, pore system. It has been determined that aggregates with extensive capillary pore systems are subject to durability problems due to failure after repeated freeze and thaw cycles.

A unique apparatus was designed and constructed by the Iowa DOT Materials Laboratory personnel which measures the pore system of an aggregate particle in a relatively simple, quick and environmentally safe test. the test is referred to as the "Iowa Pore Index Test". This test, in conjunction with chemical analysis, has largely taken the place of the ASTM C666 test method in Iowa.

Chemical testing is a rapid way to evaluate the salt-susceptibility of carbonate aggregates by directly measuring aggregate properties that were being determined by indirect physical test. X-ray fluorescence (XRF), X-ray diffraction (XRD), and Thermogravimetric analysis (TGA), along with the Iowa pore index test, is used to generate an overall quality number.

*•X-ray fluorescence (XRF) provides an elemental analysis used to calculate oxide percents.*

•*X-ray diffraction (XRD) determines mineralogy and is used primarily to determine purity of dolomite crystals.*

•*Thermogravimetric analysis (TGA) determines grain and crystallite size and some mineralogy.*

The ASTM test takes approximately 6 months to complete. Chemical testing can normally be completed in one week, and through years of in-house research, has proven to be a more reliable method to predict the aggregate's durability.

Soundness

Through the chemical testing research, an alternative method of predicting a coarse, carbonate aggregate's resistance to freeze and thaw cycles has been developed. It is suspected that the principle cause of aggregate failure is due to the clay content of the stone. Because clays are aluminosilicate minerals, the amount of alumina in the aggregate will be a measure of the clay content in the stone.

We use this test as a screening method for carbonate aggregates. If an aggregate sample fails the alumina content specification ($Al_2O_3$), the 'A' freeze and thaw test will be performed to determine compliance. The alumina test does not indicate other characteristics such as the presence of soft oolites, which could cause 'A' F & T non-compliance.

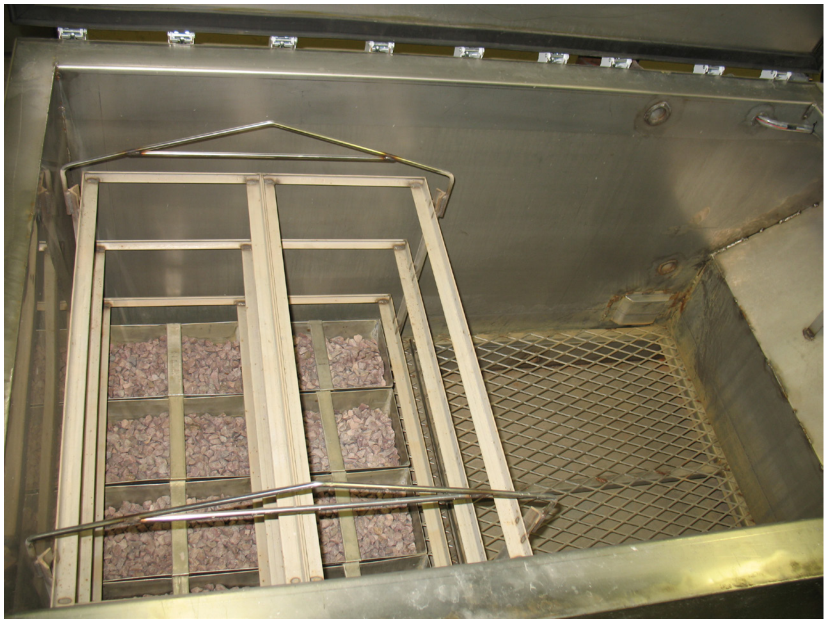
# Method of Test for Determining the Soundness of Aggregates by Freezing and Thawing

Test samples of coarse aggregate are alternately frozen and thawed for a prescribed number of cycles-16 in Method "A" for higher quality requirements, and 25 cycles in Method "C" for lower quality requirements.  In both methods, the percentage passing the No. 8 sieve, computed to a clean dry weight basis, is reported as the soundness loss.

Method "A": 0.5% methyl alcohol is added to water in which the sample is immersed for thawing.  This test is particularly severe on limestone aggregates that contain 5% or more of insoluble material in the clay or silt-size particle range.  Generally, this is also the limestone that fails to perform well when the use of sound stone is required.

Method "C": Test samples are thawed in water only.  Freezing and thawing in water is not particularly severe, hence 25 cycles are required on this test while only 16 cycles are required when the water-alcohol solution is used.  Reasonably clean, coarse aggregate usually performs well in this test, and it is specified for materials not requiring high quality aggregates.

*Freezer*



*Aggregate loaded in freezer for testing*

## Specific Gravity

Specific Gravity is a property that can be determined for all materials and is important for the aggregate inspector to understand. Simply defined, specific gravity is the relative density of a material to water, or the number of times heavier a material is than water.

The specific gravity of aggregate to be used in a Portland cement concrete (PCC) mix is determined, at time of use, by the Pycnometer Method in Iowa. This method is described in I.M. 307. Personnel performing this test must possess an Aggregate Technician Certification.

PCC mix designs are based on volumetrics, which, for the aggregate portion of the mix, requires that the amount of each of the aggregates to be incorporated, per cubic yard of mix, be based on the "saturated surface-dry"(SSD) weight of the individual material.

SSD is defined as neither absorbing water from, nor contributing water to the concrete mix. The aggregate particles have all the moisture they can absorb with no "free" moisture on the particle surfaces.

The bulk SSD specific gravity of each aggregate must be known to determine the correct amount of each aggregate needed in the PCC mix. The specific gravity of the aggregate is normally determined from a series of tests performed on samples obtained during the production phase of each aggregate. Most aggregate sources have a uniform specific gravity as long as production practices stay consistent. Sources, which may have variable specific gravities, will usually be designated with a "DWU" (determined when used) in the T-203 source instructional memorandum.

The specific gravity test performed at time of use (the plant site) is for verification purposes and to figure moisture percentages. The specific gravity to be used in determining batch weights is the one listed in the T-203. When the source indicates it is a “DWU”, the plant technician is to call the appropriate District Materials office for the current specific gravity.

The test results by the plant inspector at time of use should be within 0.020 of the intended specific gravity. If the result is not within this tolerance, the plant inspector should rerun the test. If the result is still not in conformance, the plant inspector is to notify the District Materials office for investigation.


*Pycnometers*

# *Specific Gravity Problems*

Calculate the specific gravity to the nearest 0.01 saturated-surface-dry (SSD) from 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

Given:

1. S = 2000 (C.A.)
   P = 2725.7
   W= 3945.2 Sp.Gr. (SSD) =

2. S = 1000 (F.A.)
   P = 1524.6
   W= 2146.6 Sp.Gr.(SSD) =

3. S = 1000
   P = 1485.9
   W= 2107.1 Sp.Gr. (SSD) =

4. S = 2000
   P = 2739.9
   W= 3976.2 Sp.Gr. (SSD) =

5. S = 2000
   P = 2637.8
   W= 3874.8 Sp.Gr. (SSD) =

# *Specific Gravity Problem Solutions*

1. S = 2000 g. P = 2725.7 g. W= 3945.2 g.

$$\textbf{Sp.Gr. (SSD)} = \frac{2000\text{ g.}}{(2725.7\text{ g.} + 2000\text{ g.}) - 3945.2\text{ g.}} = \frac{2000\text{ g.}}{780.5\text{ g.}} = 2.562 = 2.56$$

2. S = 1000 g. P = 1524.6 g. W= 2146.6.2 g.

$$\textbf{Sp.Gr. (SSD)} = \frac{1000\text{ g.}}{(1524.6\text{ g.} + 1000\text{ g.}) - 2146.6\text{ g.}} = \frac{1000\text{ g.}}{378.0\text{ g.}} = 2.645 = 2.65$$

3. S = 1000 g. P = 1485.9 g. W= 2107.1 g.

$$\textbf{Sp.Gr. (SSD)} = \frac{1000\text{ g.}}{(1485.9\text{ g.} + 1000\text{ g.}) - 2107.1\text{ g.}} = \frac{1000\text{ g.}}{378.8\text{ g.}} = 2.639 = 2.64$$

4. S = 2000 g. P = 2739.9 g. W= 3976.2 g.

$$\textbf{Sp.Gr. (SSD)} = \frac{2000\text{ g.}}{(2739.9\text{ g.} + 2000\text{ g.}) - 3976.2\text{ g.}} = \frac{2000\text{ g.}}{763.7\text{ g.}} = 2.619 = 2.62$$

5. S = 2000 g. P = 2637.8 g. W= 3874.8 g.

$$\textbf{Sp.Gr. (SSD)} = \frac{2000\text{ g.}}{(2637.8\text{ g.} + 2000\text{ g.}) - 3874.8\text{ g.}} = \frac{2000\text{ g.}}{763.0\text{ g.}} = 2.621 = 2.62$$

# *Moisture Tests (I.M. 308)*

Calculate the percent of free moisture of each of the examples below by using the following formula:

$$\text{Percent Moisture} = \frac{(W - W_1)(G_s)(100)}{(G_s - 1)(s)}$$

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

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

$G_s$ = Specific Gravity of material in a saturated-surface-dry condition (this is obtained from Method I.M. 307).

s = Weight in grams of wet sample

**What is the percent of free moisture in the aggregate when:**

1. $W = 3916.5$ $W_1 = 3907.0$ $G_s = 2.61$ $s = 2000.0$

2. $W = 2096.5$ $W_1 = 2078.5$ $G_s = 2.66$ $s = 1000.0$

3. $W = 3903.5$ $W_1 = 3911.0$ $G_s = 2.70$ $s = 2000.0$

4. $W = 2204.5$ $W_1 = 2184.0$ $G_s = 2.60$ $s = 1000.0$

# *Moisture Tests (I.M. 308) Solutions*

**What is the percent of free moisture in the aggregate when:**

1. $W = 3916.5$ g. $W_1 = 3907.0$ g. $G_s = 2.61$ $s = 2000.0$ g.

$$\frac{\mathbf{(3916.5\ g. - 3907.0\ g.)(2.61)(100)}}{\mathbf{(2.61 - 1) \times 2000\ g.}} = \frac{\mathbf{2479.5\ g.}}{\mathbf{3220.0\ g.}} = \mathbf{0.77 = 0.8\%}$$

2. $W = 2096.5$ $W_1 = 2078.5$ $G_s = 2.66$ $s = 1000.0$

$$\frac{\mathbf{(2096.5\ g. - 2078.5\ g.)(2.66)(100)}}{\mathbf{(2.66 - 1) \times 1000\ g.}} = \frac{\mathbf{4788.0\ g.}}{\mathbf{1660.0\ g.}} = \mathbf{2.88 = 2.9\%}$$

3. $W = 3903.5$ $W_1 = 3911.0$ $G_s = 2.70$ $s = 2000.0$

$$\frac{\mathbf{(3903.5\ g. - 3911.0\ g.)(2.70)(100)}}{\mathbf{(2.70 - 1) \times 2000\ g.}} = \mathbf{-}\frac{\mathbf{2025.0\ g.}}{\mathbf{3400.0\ g.}} = \mathbf{-0.59 = -0.6\%}$$

4. $W = 2204.5$ $W_1 = 2184.0$ $G_s = 2.60$ $s = 1000.0$

$$\frac{\mathbf{(2204.5\ g. - 2184.0\ g.)(2.60)(100)}}{\mathbf{(2.60 - 1) \times 1000\ g.}} = \frac{\mathbf{5330.0\ g.}}{\mathbf{1600.0\ g.}} = \mathbf{3.33 = 3.3\%}$$

# Moisture Corrections

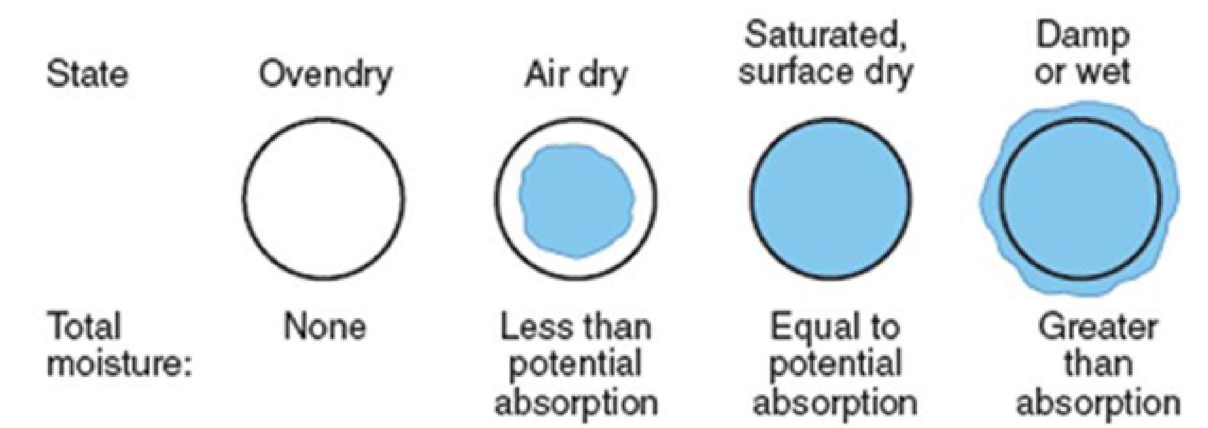
Aggregates can be in four different states.  They are the following:

**Oven dry** – There is no moisture inside or outside of the aggregate

**Air dry** -   The aggregate has moisture on the inside, but is not completely saturated. The aggregate could still absorb moisture.

**Saturated Surface Dry** – The aggregate contains all the moisture it can hold, but there is no excess moisture on the aggregate.

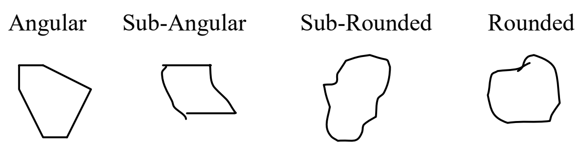
**Damp or wet** – The aggregate contains all the moisture it can hold and there is excess moisture on the surface.




Batch weights for concrete mixes are calculated using saturated surface dry (SSD) condition for the aggregates.  Aggregates coming from the stockpiles are rarely in the SSD condition, so they are tested using the Moisture test taught in Aggregate Technician (IM 308).  This will give the percentage of moisture for the aggregate. Aggregates can also be in the air dry state, which would allow them to absorb water, but this is not common.  If the technician does have an aggregate with a negative moisture (absorption), they must adjust the mix for the absorption.  The maximum permissible absorption is 0.5%.  Since an absorption is rare, there will not be a lot of class time spent on this procedure.  If the technician does run into an absorption in the field and needs assistance, they should contact their DOT PCC technician.  Normally, aggregate will be in a damp/ wet condition and adjusting batches for that condition will be discussed.   As was stated previously original batch weights are calculated with aggregates in SSD.  Once the aggregate has been tested for moisture and the correct moisture content is calculated, the aggregate batch weights need to be adjusted.  After adjusting the batch weights, the moisture in the aggregate will be used in determining the basic water and the maximum water.  Moisture content in excess of 0.5% between succesive batches must be prevented.

## Shape and Surface Texture

Particle shape of either coarse or fine aggregate may be angular, sub-angular, sub-rounded, or rounded.




Aggregate particles should ideally be equal dimensionally and free of excessive amounts of flat and elongated pieces. Long, slender aggregate pieces should be avoided. The shape of aggregate particles many times depends on the type of crusher used in the processing operation.
Particle shape and surface texture have a definite bearing on the quality of the finished product. Base courses composed of angular particles will compact and key together to form a dense, tight base, while elongated and rounded particles will slide and roll without compacting.

On the other hand, rounded particles tend to make plastic concrete. The texture of aggregate particles is normally defined in the following sequence: lithographic, sub-lithographic, fine-grained, medium grained, and coarse grained. Lithographic and fine-grained particles are polished quite easily by normal traffic wear and in time become a maintenance problem.

## Gradation

Gradation is the particle size distribution of aggregates determined by using sieves with square openings. Limits are usually specified for the percentage of material passing each sieve. There are several reasons for specifying grading limits and maximum aggregate size. Deviations from the grading limits seriously affect the uniformity of finished work.

## Dense Graded Aggregate:

Dense graded aggregates contain a proportion of material in each particle size present so as to minimize the void spaces between particles.

## Gap Graded Aggregate:

Gap or open-graded aggregates contain too great an amount of particles of nearly the same size. This produces an open-type mixture with large void spaces. There are not enough of the smaller sizes to fill the voids between the larger sizes.

## Summary-Aggregates

For the most purposes, aggregates must conform to certain requirements and should consist of clean, hard, strong, and durable particles free of chemicals, coatings of clay, or other fine materials that may affect construction.

Weak, friable, or freeze-thaw susceptible aggregate particles are undesirable for normal open highway construction. Aggregate containing natural shale or shale particles, soft and porous particles, and certain types of chert should be especially avoided since they have poor resistance to weathering. Visual inspection may often disclose weaknesses in coarse aggregates.

## Fineness Modulus

Fineness Modulus (F.M.) is an index, or single number, to describe a gradation curve. The F.M for Portland Cement Concrete (PCC) sand is determined using the cumulative percent retained on specified sieves, as described in Materials I.M. 302.

The F.M. of sand being produced for use in PCC must be within specification requirements detailed in Materials I.M. 409. (Minimum 2.60)

Fineness Modulus is also determined for the combination of aggregates used in Hot Mix Asphalt (HMA) and detailed in Materials I.M. 501.

The mathematical formulas for determining the F.M. look different for PCC and HMA, but the result will be similar. The higher or larger the result, the coarser graded the aggregate

# SECTION VI
# SIEVE ANALYSIS

# Section VI
# Sieve Analysis
### (IM 302)

## General Requirements

Aggregate sieve analysis procedures are governed by the Standard Specifications of the Iowa Department of Transportation and the Materials Office Instructional Memorandum Manual. The applicable test methods in the Materials Manual are included primarily in the 300 series under the subsection "Aggregate"


Sieve analysis is nothing more than the separation of a material based on particle size. For example, material that passes a 1 1/2 in. sieve and is retained on a 1 in. sieve would not contain any particle larger than 1 1/2 in. nor smaller than 1 in. Sieves are normally arranged in a "nest" with the largest wire opening at the top of the nest and the smallest at the bottom. Care should be taken to ensure the sieves are not overloaded.

Iowa Department of Transportation Standard Specifications normally set limits on the percent passing a given sieve.

Form 820180ex

| | | | |
|---|---|---|---|
| Lab. No.: | 1 | | |
| Material: | Fine Aggregate PCC | Grad. No.: | 1 |
| Co. & Proj.#: | | | |
| Producer: | | | |
| Contractor: | | | |
| Sampled By: | Date: | | |
| Sample Loc.: | | | |

| | | | |
|---|---|---|---|
| Original Dry Weight: | 511.3 | Total Minus No. 4 (W1): | |
| Dry Weight Washed: | 509.0 | Reduced Minus No. 4 (W2) | |
| Washing Loss: | | Conversion Factor: W1 ÷ W2 | |
| | | Calculated Weight (A)=Conversion Factor x (B) | |

| Sieve Size | Reduced Minus No. 4 | Total or Calc. Weight Retd. | % Retained | % Passing | Specs. |
|---|---|---|---|---|---|
| 1½” | | | | | |
| 1” | | | | | |
| ¾” | | | | | |
| ½” | | | | | |
| ⅜” | | 0.0 | | | |
| No.4 | | 19.1 | | | |
| No. 8 | (B) | 98.3 (A) | | | |
| No.16 | (B) | 124.0 (A) | | | |
| No. 30 | (B) | 160.9 (A) | | | |
| No. 50 | (B) | 77.2 (A) | | | |
| No. 100 | (B) | 22.6 (A) | | | |
| No. 200 | (B) | 7.3 (A) | | | |
| Washing Loss | | | | | |
| Pan | (B) | 0.4 (A) | | | |
| Total | | | | | |
| Accuracy Check | | | | | |

| ***Wash Sample*** | | | | |
|---|---|---|---|---|
| | Original Dry Weight: | | | |
| | Dry Weight Washed: | | | |
| | Washing Loss: | | | |
| Sieve Size | Weight Retd. | % Retd. | % Passing | Specs. |
| No. 200 | | | | |
| Washing Loss | | | | |
| Pan | | | | |

| | | |
|---|---|---|
| Date Reported: | Cert No.: | |
| Tested By: | | |

NOTE: No more than 200 grams should be retained on the 8” sieves. No more than 850 grams should be retained on the 12” No. 4 sieve, and a maximum of 450 grams on the No. 8 and smaller sieves.

Comments: ________________________________________________

Form 820180ex

| | | |
|---|---|---|
| Lab. No.: | 1 | |
| Material: | Fine Aggregate PCC | Grad. No.: 1 |
| Co. & Proj.#: | | |
| Producer: | | |
| Contractor: | | |
| Sampled By: | Date: | |
| Sample Loc.: | | |

| | | | |
|---|---|---|---|
| Original Dry Weight: | 511.3 | Total Minus No. 4 (W1): | |
| Dry Weight Washed: | 509.0 | Reduced Minus No. 4 (W2) | |
| Washing Loss: | 2.3 | Conversion Factor: W1 ÷ W2 | |
| | | Calculated Weight (A)=Conversion Factor x (B) | |

| Sieve Size | Reduced Minus No. 4 | Total or Calc. Weight Retd. | % Retained | % Passing | Specs. |
|---|---|---|---|---|---|
| 1½” | | | | | |
| 1” | | | | | |
| ¾” | | | | | |
| ½” | | | | | |
| ⅜” | | 0.0 | 0.0 | 100.0% | 100 |
| No.4 | | 19.1 | 3.7 | 96.3 | 90-100 |
| No. 8 | (B) | 98.3 (A) | 19.2 | 77.1 | 70-100 |
| No.16 | (B) | 124.0 (A) | 24.3 | 52.8 | |
| No. 30 | (B) | 160.9 (A) | 31.5(31.4) | 21.4 | 10-60 |
| No. 50 | (B) | 77.2 (A) | 15.1 | 6.3 | |
| No. 100 | (B) | 22.6 (A) | 4.4 | 1.9 | |
| No. 200 | (B) | 7.3 (A) | 1.4 | 0.5 | 0-1.5 |
| Washing Loss | | 2.3 | 0.5 | | |
| Pan | (B) | 0.4 (A) | | | |
| Total | | 512.1 | 100.1(100.0) | | |
| Accuracy Check | | 100.2 | | | |

| ***Wash Sample*** | | | | |
|---|---|---|---|---|
| | Original Dry Weight: | | | |
| | Dry Weight Washed: | | | |
| | Washing Loss: | | | |
| Sieve Size | Weight Retd. | % Retd. | % Passing | Specs. |
| No. 200 | | | | |
| Washing Loss | | | | |
| Pan | | | | |

| | | |
|---|---|---|
| Date Reported: | Cert No.: | |
| Tested By: | | |

NOTE: No more than 200 grams should be retained on the 8” sieves. No more than 850 grams should be retained on the 12” No. 4 sieve, and a maximum of 450 grams on the No. 8 and smaller sieves.

Comments: ______________________________________________

Given the following information, complete the **Fine Aggregate Gradation** worksheet.

| | |
|---|---|
| Original Dry Weight | 542.0 |
| Dry Weight Washed | 539.6 |
| Weight Retained No. 8 sieve | 101.3 |
| Weight Retained No. 16 sieve | 160.7 |
| Weight Retained No. 30 sieve | 179.0 |
| Weight Retained No. 50 sieve | 80.0 |
| Weight Retained No. 100 sieve | 10.9 |
| Weight Retained No. 200 sieve | 5.8 |
| Weight Retained, Pan | 0.3 |

Form 820180ex

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

| | | | |
|---|---|---|---|
| Original Dry Weight: | | Total Minus No. 4 (W1): | |
| Dry Weight Washed: | | Reduced Minus No. 4 (W2) | |
| Washing Loss: | | Conversion Factor: W1 ÷ W2 | |
| | | Calculated Weight (A)=Conversion Factor x (B) | |

| Sieve Size | Reduced Minus No. 4 | Total or Calc. Weight Retd. | % Retained | % Passing | Specs. |
|---|---|---|---|---|---|
| 1½” | | | | | |
| 1” | | | | | |
| ¾” | | | | | |
| ½” | | | | | |
| ⅜” | | | | | |
| No.4 | | | | | |
| No. 8 | (B) | (A) | | | |
| No.16 | (B) | (A) | | | |
| No. 30 | (B) | (A) | | | |
| No. 50 | (B) | (A) | | | |
| No. 100 | (B) | (A) | | | |
| No. 200 | (B) | (A) | | | |
| Washing Loss | | | | | |
| Pan | (B) | (A) | | | |
| Total | | | | | |
| Accuracy Check | | | | | |

| | | | | |
|---|---|---|---|---|
| ***Wash Sample*** | Original Dry Weight: | | | |
| | Dry Weight Washed: | | | |
| | Washing Loss: | | | |
| Sieve Size | Weight Retd. | % Retd. | % Passing | Specs. |
| No. 200 | | | | |
| Washing Loss | | | | |
| Pan | | | | |

| | | |
|---|---|---|
| Date Reported: | Cert No.: | |
| Tested By: | | |

NOTE: No more than 200 grams should be retained on the 8” sieves. No more than 850 grams should be retained on the 12” No. 4 sieve, and a maximum of 450 grams on the No. 8 and smaller sieves.

Comments: ______________________________

Form 820180ex

| | | |
|---|---|---|
| Lab. No.: | 2 | |
| Material: | Fine Aggregate | Grad. No.: |
| Co. & Proj.#: | | |
| Producer: | | |
| Contractor: | | |
| Sampled By: | Date: | |
| Sample Loc.: | | |

| | | | |
|---|---|---|---|
| Original Dry Weight: | 542.0 | Total Minus No. 4 (W1): | |
| Dry Weight Washed: | 539.6 | Reduced Minus No. 4 (W2) | |
| Washing Loss: | 2.4 | Conversion Factor: W1 ÷ W2 | |
| | | Calculated Weight (A)=Conversion Factor x (B) | |

| Sieve Size | Reduced Minus No. 4 | Total or Calc. Weight Retd. | % Retained | % Passing | Specs. |
|---|---|---|---|---|---|
| 1½” | | | | | |
| 1” | | | | | |
| ¾” | | | | | |
| ½” | | | | | |
| ⅜” | | | | | |
| No.4 | | 0.0 | 0.0 | 100.0 | |
| No. 8 | (B) | 101.3 (A) | 18.7(8) | 81.2 | |
| No.16 | (B) | 160.7 (A) | 29.6(7) | 51.5 | |
| No. 30 | (B) | 179.0 (A) | 33.0(1) | 18.4 | |
| No. 50 | (B) | 80.0 (A) | 14.8 | 3.6 | |
| No. 100 | (B) | 10.9 (A) | 2.0 | 1.6 | |
| No. 200 | (B) | 5.8 (A) | 1.1 | 0.5 | |
| Washing Loss | | 2.4 | 0.5 | | |
| Pan | (B) | 0.3 (A) | | | |
| Total | | 540.4 | 99.7 | | |
| Accuracy Check | | 99.7 | (100.0) | | |

| | | | | |
|---|---|---|---|---|
| ***Wash Sample*** | Original Dry Weight: | | | |
| | Dry Weight Washed: | | | |
| | Washing Loss: | | | |
| Sieve Size | Weight Retd. | % Retd. | % Passing | Specs. |
| No. 200 | | | | |
| Washing Loss | | | | |
| Pan | | | | |

| | |
|---|---|
| Date Reported: | Cert No.: |
| Tested By: | |

NOTE: No more than 200 grams should be retained on the 8” sieves. No more than 850 grams should be retained on the 12” No. 4 sieve, and a maximum of 450 grams on the No. 8 and smaller sieves.

Comments: ____________________________________________

# Fineness Modulus Calculation
# (Fine Aggregate for PCC)
# AASHTO T27-93

Determine the cumulative percents retained for each sieve, starting with the largest sieve retaining any material, through the #100 sieve. Add the cumulative percents retained and divide that sum by 100. results are reported to the nearest 0.01 (one-hundreth).

**Practice Problem**

| Sieves | Percent Retained | Cumulative Percent Retained |
|---|---|---|
| **⅜"** | **0.0** | |
| **#4** | **3.7** | |
| **#8** | **19.2** | |
| **#16** | **24.3** | |
| **#30** | **31.4** | |
| **#50** | **15.1** | |
| **#100** | **4.4** | |

**Total Cumulative Percent =**

**Fineness Modulus =**

## Fineness Modulus Calculation
## (Fine Aggregate for PCC)
## AASHTO T27-93

Determine the cumulative percents retained for each sieve, starting with the largest sieve retaining any material, through the #100 sieve. Add the cumulative percents retained and divide that sum by 100. results are reported to the nearest 0.01 (one-hundreth).

**Practice Problem - Answer**

| Sieves | Percent Retained | Cumulative Percent Retained |
|---|---|---|
| **⅜"** | **0.0** | **0.0** |
| **#4** | **3.7** | **3.7** |
| **#8** | **19.2** | **22.9** |
| **#16** | **24.3** | **47.2** |
| **#30** | **31.4** | **78.6** |
| **#50** | **15.1** | **93.7** |
| **#100** | **4.4** | **98.1** |

**Total Cumulative Percent =** | **344.2** |

**Fineness Modulus = 344.2 ÷ 100 = 3.44**

**Fineness Modulus Calculation**
**(Fine Aggregate for PCC)**
**AASHTO T27-93**

Determine the cumulative percents retained for each sieve, starting with the largest sieve retaining any material, through the #100 sieve. Add the cumulative percents retained and divide that sum by 100. results are reported to the nearest 0.01 (one-hundreth).

| Sieves | Percent Retained | Cumulative Percent Retained |
|---|---|---|
| ⅜" | | |
| #4 | | |
| #8 | | |
| #16 | | |
| #30 | | |
| #50 | | |
| #100 | | |

**Total Cumulative Percent =**

**Fineness Modulus =**

Form 820180ex

| | | |
|---|---|---|
| Lab. No.: | 3 | |
| Material: | Coarse Aggregate PCC | Grad. No.: 3 |
| Co. & Proj.#: | | |
| Producer: | | |
| Contractor: | | |
| Sampled By: | Date: | |
| Sample Loc.: | | |

| | | | |
|---|---|---|---|
| Original Dry Weight: | 3759.4 | Total Minus No. 4 (W1): | |
| Dry Weight Washed: | | Reduced Minus No. 4 (W2) | |
| Washing Loss: | | Conversion Factor: W1 ÷ W2 | |
| | | Calculated Weight (A)=Conversion Factor x (B) | |

| Sieve Size | Reduced Minus No. 4 | Total or Calc. Weight Retd. | % Retained | % Passing | Specs. |
|---|---|---|---|---|---|
| 1½" | | 0.0 | | | |
| 1" | | 23.0 | | | |
| ¾" | | 381.2 | | | |
| ½" | | 1476.8 | | | |
| ⅜" | | 1243.5 | | | |
| No.4 | | 501.0 | | | |
| No. 8 | (B) | 100.7 (A) | | | |
| No.16 | (B) | (A) | | | |
| No. 30 | (B) | (A) | | | |
| No. 50 | (B) | (A) | | | |
| No. 100 | (B) | (A) | | | |
| No. 200 | (B) | (A) | | | |
| Washing Loss | | | | | |
| Pan | (B) | 30.8 (A) | | | |
| Total | | | | | |
| Accuracy Check | | | | | |

| ***Wash Sample*** | | | | |
|---|---|---|---|---|
| | Original Dry Weight: | | 2603.3 | |
| | Dry Weight Washed: | | 2590.4 | |
| | Washing Loss: | | | |
| Sieve Size | Weight Retd. | % Retd. | % Passing | Specs. |
| No. 200 | | | | |
| Washing Loss | | | | |
| Pan | 1.1 | | | |

| | | |
|---|---|---|
| Date Reported: | Cert No.: | |
| Tested By: | | |

NOTE: No more than 200 grams should be retained on the 8" sieves. No more than 850 grams should be retained on the 12" No. 4 sieve, and a maximum of 450 grams on the No. 8 and smaller sieves.

Comments: ______________________________________________

Form 820180ex

| | | |
|---|---|---|
| Lab. No.: | 3 | |
| Material: | Coarse Aggregate PCC | Grad. No.: 3 |
| Co. & Proj.#: | | |
| Producer: | | |
| Contractor: | | |
| Sampled By: | Date: | |
| Sample Loc.: | | |

| | | | |
|---|---|---|---|
| Original Dry Weight: | 3759.4 | Total Minus No. 4 (W1): | |
| Dry Weight Washed: | | Reduced Minus No. 4 (W2) | |
| Washing Loss: | | Conversion Factor: W1 ÷ W2 | |
| | | Calculated Weight (A)=Conversion Factor x (B) | |

| Sieve Size | Reduced Minus No. 4 | Total or Calc. Weight Retd. | % Retained | % Passing | Specs. |
|---|---|---|---|---|---|
| 1½” | | 0.0 | 0.0 | 100.0 | 100 |
| 1” | | 23.0 | 0.6 | 99.4 | 95-100 |
| ¾” | | 381.2 | 10.1 | 89.3 | |
| ½” | | 1476.8 | 39.3(39.4) | 49.9 | 25-60 |
| ⅜” | | 1243.5 | 33.1 | 16.8 | |
| No.4 | | 501.0 | 13.3 | 3.5 | 0-10 |
| No. 8 | (B) | 100.7 (A) | 2.7 | 0.8 | 0-5 |
| No.16 | (B) | (A) | | | |
| No. 30 | (B) | (A) | | | |
| No. 50 | (B) | (A) | | | |
| No. 100 | (B) | (A) | | | |
| No. 200 | (B) | (A) | | | |
| Washing Loss | | | | | |
| Pan | (B) | 30.8 (A) | 0.8 | | |
| Total | | 3757.0 | 99.9(100.0) | | |
| Accuracy Check | | 99.9 | | | |

| **_Wash Sample_** | | | | |
|---|---|---|---|---|
| | Original Dry Weight: | | 2603.3 | |
| | Dry Weight Washed: | | 2590.4 | |
| | Washing Loss: | | 12.9 | |
| Sieve Size | Weight Retd. | % Retd. | % Passing | Specs. |
| No. 200 | | | 0.5 | 0-1.5 |
| Washing Loss | 12.9 | 0.5 | | |
| Pan | 1.1 | | | |

| | |
|---|---|
| Date Reported: | Cert No.: |
| Tested By: | |

NOTE: No more than 200 grams should be retained on the 8” sieves. No more than 850 grams should be retained on the 12” No. 4 sieve, and a maximum of 450 grams on the No. 8 and smaller sieves.

Comments: ______________________________________________

Given the following information, complete the **Coarse Aggregate Gradation** worksheet.

| | |
|---|---|
| Original Dry Weight | 5348.7 |
| Weight Retained 1" sieve | 169.0 |
| Weight Retained 3/4" sieve | 516.7 |
| Weight Retained 1/2" sieve | 1817.0 |
| Weight Retained 3/8" sieve | 1798.3 |
| Weight Retained No. 4 | 713.9 |
| Weight Retained No. 8 | 307.1 |
| Weight Retained in Pan | 24.6 |
| | |
| Wash Sample Original Dry Weight | 2582.8 |
| Wash Sample Dry Weight Washed | 2561.9 |
| Wash Sample, Weight Retained in Pan | 0.9 |

Form 820180ex

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

| | | | |
|---|---|---|---|
| Original Dry Weight: | | Total Minus No. 4 (W1): | |
| Dry Weight Washed: | | Reduced Minus No. 4 (W2) | |
| Washing Loss: | | Conversion Factor: W1 ÷ W2 | |
| | | Calculated Weight (A)=Conversion Factor x (B) | |

| Sieve Size | Reduced Minus No. 4 | Total or Calc. Weight Retd. | % Retained | % Passing | Specs. |
|---|---|---|---|---|---|
| 1½” | | | | | |
| 1” | | | | | |
| ¾” | | | | | |
| ½” | | | | | |
| ⅜” | | | | | |
| No.4 | | | | | |
| No. 8 | (B) | (A) | | | |
| No.16 | (B) | (A) | | | |
| No. 30 | (B) | (A) | | | |
| No. 50 | (B) | (A) | | | |
| No. 100 | (B) | (A) | | | |
| No. 200 | (B) | (A) | | | |
| Washing Loss | | | | | |
| Pan | (B) | (A) | | | |
| Total | | | | | |
| Accuracy Check | | | | | |

***Wash Sample***

| | | | | |
|---|---|---|---|---|
| | Original Dry Weight: | | | |
| | Dry Weight Washed: | | | |
| | Washing Loss: | | | |
| Sieve Size | Weight Retd. | % Retd. | % Passing | Specs. |
| No. 200 | | | | |
| Washing Loss | | | | |
| Pan | | | | |

| | | |
|---|---|---|
| Date Reported: | Cert No.: | |
| Tested By: | | |

NOTE: No more than 200 grams should be retained on the 8” sieves. No more than 850 grams should be retained on the 12” No. 4 sieve, and a maximum of 450 grams on the No. 8 and smaller sieves.

Comments: ________________________________________________

Form 820180ex

| | | |
|---|---|---|
| Lab. No.: | 4 | |
| Material: | Coarse Aggregate | Grad. No.: |
| Co. & Proj.#: | | |
| Producer: | | |
| Contractor: | | |
| Sampled By: | Date: | |
| Sample Loc.: | | |

| | | | |
|---|---|---|---|
| Original Dry Weight: | 5348.7 | Total Minus No. 4 (W1): | |
| Dry Weight Washed: | | Reduced Minus No. 4 (W2) | |
| Washing Loss: | | Conversion Factor: W1 ÷ W2 | |
| | | Calculated Weight (A)=Conversion Factor x (B) | |

| Sieve Size | Reduced Minus No. 4 | Total or Calc. Weight Retd. | % Retained | % Passing | Specs. |
|---|---|---|---|---|---|
| 1½” | | 0.0 | 0.0 | 100.0 | |
| 1” | | 169.0 | 3.2 | 96.8 | |
| ¾” | | 516.7 | 9.7 | 87.1 | |
| ½” | | 1817.0 | 34.0 | 53.1 | |
| ⅜” | | 1798.3 | 33.6 | 19.5 | |
| No.4 | | 713.9 | 13.3 | 6.2 | |
| No. 8 | (B) | 307.1 (A) | 5.7 | 0.5 | |
| No.16 | (B) | (A) | | | |
| No. 30 | (B) | (A) | | | |
| No. 50 | (B) | (A) | | | |
| No. 100 | (B) | (A) | | | |
| No. 200 | (B) | (A) | | | |
| Washing Loss | | | | | |
| Pan | (B) | 24.6 (A) | 0.5 | | |
| Total | | 5346.6 | 100.0 | | |
| Accuracy Check | | 100.0 | | | |

| ***Wash Sample*** | | | | |
|---|---|---|---|---|
| | Original Dry Weight: | | 2582.8 | |
| | Dry Weight Washed: | | 2561.9 | |
| | Washing Loss: | | 20.9 | |
| Sieve Size | Weight Retd. | % Retd. | % Passing | Specs. |
| No. 200 | | | 0.8 | |
| Washing Loss | 20.9 | 0.8 | | |
| Pan | 0.9 | | | |

| | | |
|---|---|---|
| Date Reported: | Cert No.: | |
| Tested By: | | |

NOTE: No more than 200 grams should be retained on the 8” sieves. No more than 850 grams should be retained on the 12” No. 4 sieve, and a maximum of 450 grams on the No. 8 and smaller sieves.

Comments: ______________________________

Form 820180ex

| | | |
|---|---|---|
| Lab. No.: | 5 | |
| Material: | ¾ " Combined Aggregate | Grad. No.: |
| Co. & Proj.#: | (Using 12" diameter sieves) | |
| Producer: | | |
| Contractor: | | |
| Sampled By: | Date: | |
| Sample Loc.: | | |

| | | | |
|---|---|---|---|
| Original Dry Weight: | 2247.5 | Total Minus No. 4 (W1): | |
| Dry Weight Washed: | 2091.9 | Reduced Minus No. 4 (W2) | |
| Washing Loss: | | Conversion Factor: W1 ÷ W2 | |
| | | Calculated Weight (A)=Conversion Factor x (B) | |

| Sieve Size | Reduced Minus No. 4 | Total or Calc. Weight Retd. | % Retained | % Passing | Specs. |
|---|---|---|---|---|---|
| 1½" | | | | | |
| 1" | | 0.0 | | | |
| ¾" | | 27.0 | | | |
| ½" | | 243.3 | | | |
| ⅜" | | 301.1 | | | |
| No.4 | | 511.8 | | | |
| No. 8 | (B) | 432.0 (A) | | | |
| No.16 | (B) | 211.6 (A) | | | |
| No. 30 | (B) | 116.9 (A) | | | |
| No. 50 | (B) | 100.4 (A) | | | |
| No. 100 | (B) | 83.0 (A) | | | |
| No. 200 | (B) | 54.0 (A) | | | |
| Washing Loss | | | | | |
| Pan | (B) | 8.3 (A) | | | |
| Total | | | | | |
| Accuracy Check | | | | | |

| | | |
|---|---|---|
| ***Wash Sample*** | Original Dry Weight: | |
| | Dry Weight Washed: | |
| | Washing Loss: | |

| Sieve Size | Weight Retd. | % Retd. | % Passing | Specs. |
|---|---|---|---|---|
| No. 200 | | | | |
| Washing Loss | | | | |
| Pan | | | | |

| | |
|---|---|
| Date Reported: | Cert No.: |
| Tested By: | |

NOTE: No more than 200 grams should be retained on the 8" sieves. No more than 850 grams should be retained on the 12" No. 4 sieve, and a maximum of 450 grams on the No. 8 and smaller sieves.

Comments: ______________________________

Form 820180ex

| | | |
|---|---|---|
| Lab. No.: | 5 | |
| Material: | ¾ " Combined Aggregate | Grad. No.: |
| Co. & Proj.#: | (Using 12" diameter sieves) | |
| Producer: | | |
| Contractor: | | |
| Sampled By: | Date: | |
| Sample Loc.: | | |

| | | | |
|---|---|---|---|
| Original Dry Weight: | 2247.5 | Total Minus No. 4 (W1): | |
| Dry Weight Washed: | 2091.9 | Reduced Minus No. 4 (W2) | |
| Washing Loss: | 155.6 | Conversion Factor: W1 ÷ W2 | |
| | | Calculated Weight (A)=Conversion Factor x (B) | |

| Sieve Size | Reduced Minus No. 4 | Total or Calc. Weight Retd. | % Retained | % Passing | Specs. |
|---|---|---|---|---|---|
| 1½" | | | | | |
| 1" | | 0.0 | 0.0 | 100.0 | |
| ¾" | | 27.0 | 1.2 | 98.8 | |
| ½" | | 243.3 | 10.8 | 88.0 | |
| ⅜" | | 301.1 | 13.4 | 74.6 | |
| No.4 | | 511.8 | 22.8(22.9) | 51.7 | |
| No. 8 | (B) | 432.0 (A) | 19.2 | 32.5 | |
| No.16 | (B) | 211.6 (A) | 9.4 | 23.1 | |
| No. 30 | (B) | 116.9 (A) | 5.2 | 17.9 | |
| No. 50 | (B) | 100.4 (A) | 4.5 | 13.4 | |
| No. 100 | (B) | 83.0 (A) | 3.7 | 9.7 | |
| No. 200 | (B) | 54.0 (A) | 2.4 | 7.3 | |
| Washing Loss | | 155.6 | 7.3 | | |
| Pan | (B) | 8.3 (A) | | | |
| Total | | 2245.0 | 99.9(100.0) | | |
| Accuracy Check | | 99.9 | | | |

| | | | | |
|---|---|---|---|---|
| ***Wash Sample*** | Original Dry Weight: | | | |
| | Dry Weight Washed: | | | |
| | Washing Loss: | | | |
| Sieve Size | Weight Retd. | % Retd. | % Passing | Specs. |
| No. 200 | | | | |
| Washing Loss | | | | |
| Pan | | | | |

| | |
|---|---|
| Date Reported: Cert No.: | |
| Tested By: | |

NOTE: No more than 200 grams should be retained on the 8" sieves. No more than 850 grams should be retained on the 12" No. 4 sieve, and a maximum of 450 grams on the No. 8 and smaller sieves.

Comments: ________________________________________________

Given the following information, complete the **Combined Aggregate Gradation** worksheet.

| | |
|---|---|
| Original Dry Weight | 1631.0 |
| Dry Weight Washed | 1526.5 |
| Weight Retained 1/2" sieve | 13.1 |
| Weight Retained 3/8" sieve | 295.4 |
| Weight Retained No. 4 sieve | 383.7 |
| Weight Retained No. 8 sieve | 396.0 |
| Weight Retained No. 16 sieve | 167.7 |
| Weight Retained No. 30 sieve | 86.6 |
| Weight Retained No. 50 sieve | 77.0 |
| Weight Retained No. 100 sieve | 62.3 |
| Weight Retained No. 200 sieve | 39.1 |
| Weight Retained, Pan | 6.6 |

Form 820180ex

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

| | | | |
|---|---|---|---|
| Original Dry Weight: | | Total Minus No. 4 (W1): | |
| Dry Weight Washed: | | Reduced Minus No. 4 (W2) | |
| Washing Loss: | | Conversion Factor: W1 ÷ W2 | |
| | | Calculated Weight (A)=Conversion Factor x (B) | |

| Sieve Size | Reduced Minus No. 4 | Total or Calc. Weight Retd. | % Retained | % Passing | Specs. |
|---|---|---|---|---|---|
| 1½" | | | | | |
| 1" | | | | | |
| ¾" | | | | | |
| ½" | | | | | |
| ⅜" | | | | | |
| No.4 | | | | | |
| No. 8 | (B) | (A) | | | |
| No.16 | (B) | (A) | | | |
| No. 30 | (B) | (A) | | | |
| No. 50 | (B) | (A) | | | |
| No. 100 | (B) | (A) | | | |
| No. 200 | (B) | (A) | | | |
| Washing Loss | | | | | |
| Pan | (B) | (A) | | | |
| Total | | | | | |
| Accuracy Check | | | | | |

| ***Wash Sample*** | | |
|---|---|---|
| | Original Dry Weight: | |
| | Dry Weight Washed: | |
| | Washing Loss: | |

| Sieve Size | Weight Retd. | % Retd. | % Passing | Specs. |
|---|---|---|---|---|
| No. 200 | | | | |
| Washing Loss | | | | |
| Pan | | | | |

| | |
|---|---|
| Date Reported: Cert No.: | |
| Tested By: | |

NOTE: No more than 200 grams should be retained on the 8" sieves. No more than 850 grams should be retained on the 12" No. 4 sieve, and a maximum of 450 grams on the No. 8 and smaller sieves.

Comments: ______________________________________________

Form 820180ex

| | | |
|---|---|---|
| Lab. No.: | 6 | |
| Material: | Combined Aggregate | Grad. No.: |
| Co. & Proj.#: | (with 12" sieves) | |
| Producer: | | |
| Contractor: | | |
| Sampled By: | Date: | |
| Sample Loc.: | | |

| | | | |
|---|---|---|---|
| Original Dry Weight: | 1631.0 | Total Minus No. 4 (W1): | |
| Dry Weight Washed: | 1526.5 | Reduced Minus No. 4 (W2) | |
| Washing Loss: | 104.5 | Conversion Factor: W1 ÷ W2 | |
| | | Calculated Weight (A)=Conversion Factor x (B) | |

| Sieve Size | Reduced Minus No. 4 | Total or Calc. Weight Retd. | % Retained | % Passing | Specs. |
|---|---|---|---|---|---|
| 1½" | | | | | |
| 1" | | | | | |
| ¾" | | 0.0 | 0.0 | 100.0 | |
| ½" | | 13.1 | 0.8 | 99.2 | |
| ⅜" | | 295.4 | 18.1 | 81.1 | |
| No.4 | | 383.7 | 23.5 | 57.6 | |
| No. 8 | (B) | 396.0 (A) | 24.3 | 33.3 | |
| No.16 | (B) | 167.7 (A) | 10.3 | 23.0 | |
| No. 30 | (B) | 86.6 (A) | 5.3 | 17.7 | |
| No. 50 | (B) | 77.0 (A) | 4.7 | 13.0 | |
| No. 100 | (B) | 62.3 (A) | 3.8 | 9.2 | |
| No. 200 | (B) | 39.1 (A) | 2.4 | 6.8 | |
| Washing Loss | | 104.5 | 6.8 | | |
| Pan | (B) | 6.6 (A) | | | |
| Total | | 1632.0 | 100.0 | | |
| Accuracy Check | | 100.1 | | | |

***Wash Sample***

| | | | | |
|---|---|---|---|---|
| | Original Dry Weight: | | | |
| | Dry Weight Washed: | | | |
| | Washing Loss: | | | |
| Sieve Size | Weight Retd. | % Retd. | % Passing | Specs. |
| No. 200 | | | | |
| Washing Loss | | | | |
| Pan | | | | |

| | |
|---|---|
| Date Reported: | Cert No.: |
| Tested By: | |

NOTE: No more than 200 grams should be retained on the 8" sieves. No more than 850 grams should be retained on the 12" No. 4 sieve, and a maximum of 450 grams on the No. 8 and smaller sieves.

Comments: ______________________________

# REPORTS

Form 821278
05-16

IOWA DOT
SMARTER | SIMPLER | CUSTOMER DRIVEN

# CERTIFIED GRADATION TEST REPORT

County: CLINTON
Project: WAREHOUSE STOCK
Contractor:
Contract No.:
Design:
Date: 8/30/19 Report No.: 1

☐ Certified Sample
☑ Production Verification Sample
☐ Stockpile Verification Sample

_____ Tons Taken From Approved
W.H.S. Certified And Verification Gradations Performed At Time Of Production On File. Quality Tests Met Requirements Of Iowa D.O.T. Standard Specifications

Source Name: LYONS T-203A No: A23016 Source Location: NW Sec.: 18 Twp.: 82 Range: 7E County: CLINTON

Material: GRANULAR SURFACE & SHOULDER Class: CLASS A Gradation No.: 11 Beds: FULL FACE

Material Producer: WENDLING QUARRIES INC. Destination: WAREHOUSE STOCKPILE Sampled At: STREAMFLOW @ PLANT

| Date Sampled | Sample Identification | Sampled By | Tested By | | Sieve Analysis --in. | 1.00 (26.5mm) | 3/4 in. (19mm) | 0.50 (13.2mm) | 3/8 in. (9.5mm) | No. 4 (4.75mm) | No. 8 (2.36mm) | No. 16 (1.18mm) | No. 30 (600µm) | No. 50 (300µm) | No. 100 (150µm) | Percent Passing No. 200 (75µm) | Other Test Results | clay | | Comp. | Tons |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Production Limits | | | | Max. | | 100 | 100 | 90 | | 55 | 40 | | | | | 16 | | 4% | | | |
| | | | | Min. | | | 95 | 70 | | 30 | 15 | | | | | 6 | | | | | |
| 8/01/19 | 8-1-19A | J. DOE | J. DOE | | | 100 | 100 | 84 | 66 | 43 | 30 | 24 | 20 | 17 | 14 | 9.6 | | | | Y | 12000 |
| 8/12/19 | 8-12-19A | J. DOE | J. DOE | | | 100 | 99 | 83 | 69 | 45 | 32 | 25 | 19 | 16 | 14 | 9.2 | | | | Y | 12000 |
| 8/20/19 | 8-20-19A | J. DOE | J. DOE | | | 100 | 97 | 80 | 65 | 45 | 30 | 22 | 18 | 14 | 9.9 | 7.8 | | | | Y | 12000 |
| 8/28/19 | 8-28-19A | J. DOE | J. DOE | | | 100 | 98 | 79 | 67 | 47 | 33 | 26 | 22 | 20 | 18 | 13 | | 3.5% | | Y | 12000 |
| | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | |
| Average of Gradations | | | | | | | | | | | | | | | | | | | | | |

Note to County and Resident Engineers--If County or Project Number is incorrect, please notify Inspector and Ames Office Promptly Corrected Reports will be issued

Comments

ESTIMATED QUANTITY 48,000 Tons
TOTAL PREVIOUSLY CERTIFIED 0 Tons
TOTAL CERTIFIED TO DATE 48,000 Tons
CERTIFICATION NUMBER 518000
Reported By JOHN DOE
Representing Iowa Department of Transportation

*AGREED by the contractor/producer

**Distribution:** Copies to: District Materials Engineer, Project Construction Engineer, Certified Technician, and Area Inspector

Form 821278
05-16

IOWA DOT
SMARTER I SIMPLER I CUSTOMER DRIVEN

# CERTIFIED GRADATION TEST REPORT

County CERO GORDO
Project WAREHOUSE STOCK
Contractor
Contract No.
Design
Date 6/14/19 Report No. 2

- [x] Certified Sample
- [ ] Production Verification Sample
- [ ] Stockpile Verification Sample

_____ Tons Taken From Approved W.H.S. Certified And Verification Gradations Performed At Time Of Production On File. Quality Tests Met Requirements Of Iowa D.O.T. Standard Specifications

Source Name HOLCIM SAND T-203A No. A17514 Source Location NE Sec. 19 Twp. 97 Range 2W County CERRO GORDO

Material CONCRETE SAND Class Gradation No. 1 Beds

Material Producer MARTIN MARIETTA Destination WAREHOUSE STOCKPILE Sampled At STOCKPILE @ PLANT

| Date Sampled | Sample Identification | Sampled By | Tested By | | Sieve Analysis --in. | 1.00 (26.5mm) | 3/4 in. (19mm) | 0.50 (13.2mm) | 3/8 in. (9.5mm) | No. 4 (4.75mm) | No. 8 (2.36mm) | No. 16 (1.18mm) | No. 30 (600µm) | No. 50 (300µm) | No. 100 (150µm) | Percent Passing No. 200 (75µm) | Other Test Results | F.M. target, | shale | Comp. | Tons |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Production Limits | | | | Max. | | | | | 100 | 100 | 100 | | 60 | | | 1.5 | | 3.00 | 2% | | |
| | | | | Min. | | | | | | 90 | 70 | | 10 | | | 0 | | | | | |
| 6/21/19 | 6-21-19A | J. DOE | J. DOE | | | | | | 100 | 92 | 78 | 62 | 37 | 9.0 | 0.7 | 0.4 | | 3.22 | 1.2% | Y | 1200 |
| 6/24/19 | 6-24-19A | J. DOE | J. DOE | | | | | | 100 | 91 | 79 | 64 | 43 | 13 | 1.3 | 0.6 | | 3.09 | 2.2% | **N | 300 |
| 6/24/19 | 6-24-19B | J. DOE | J. DOE | | | | | | 100 | 94 | 85 | 73 | 52 | 15 | 0.9 | 0.3 | | 2.81 | 1.1% | Y | 900 |
| 6/25/19 | 6-25-19A | J. DOE | J. DOE | | | | | | 100 | 92 | 82 | 71 | 52 | 16 | 1.3 | 0.4 | | 2.86 | 0.9% | Y | 1200 |
| 6/26/19 | 6-26-19A | J. DOE | J. DOE | | | | | | 100 | 98 | 83 | 64 | 41 | 11 | 1.2 | 0.5 | | 3.03 | 0.6% | Y | 1200 |
| 6/27/19 | 6-27-19A | J. DOE | J. DOE | | | | | | 100 | 91 | 79 | 60 | 37 | 9.6 | 0.9 | 0.3 | | 3.22 | 0.7% | Y | 1200 |
| Average of Gradations | | | | | | | | | | | | | | | | | | | | | |

Note to County and Resident Engineers--If County or Project Number is incorrect, please notify Inspector and Ames Office Promptly. Corrected Reports will be issued.

Comments
** Material isolated and removed from stockpile

ESTIMATED QUANTITY 5700 Tons
TOTAL PREVIOUSLY CERTIFIED 7200 Tons
TOTAL CERTIFIED TO DATE 12900 Tons
CERTIFICATION NUMBER 618000
Reported By JANE DOE
Representing MARTIN MARIETTA

*AGREED by the contractor/producer

**Distribution:** Copies to: District Materials Engineer, Project Construction Engineer, Certified Technician, and Area Inspector

800240E computer VER 1-06

# PCC Plant Report

| Date of Placement | | Location From | To |
|---|---|---|---|
| Mix 1 | 6/13/08 | | |
| Mix 2 | | | |
| Mix 3 | | | |
| ~~Mix 4~~ | | | |
| Mix 5 | | | |

Project No.: MP-020-1(703)136--76-40
Plant Name: AMER CONC WEBSTER CITY
Contractor: CEDAR FALLS CONST
Weather: PT CLOUDY

Contract ID: 40-0201-703
County: HAMILTON
Temp. (°F) Min: 56
Temp. (°F) Max: 79

Report No.: 1
Date This Report: 06/14/08
Date Of Last Report: N/A
Structures Des. No:

| Check Mix( x ) | |
|---|---|
| Central | |
| Ready | X |

| Check One( x ) | | SEND |
|---|---|---|
| Paving | | (Daily) |
| Structure | | (Weekly) |
| Incidental | | (Weekly) |
| Patching | X | (Weekly) |

| | 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 | M-4 | 39.50 | | 4.5 | 2.63 | 1,378 | | | | 1.2 | 2.59 | 1,361 | 825 | | | 1,443 | | 1,378 | 81 | 230.0 | 7.0 | 0.386 | 0.400 |
| 2 | | | | | | | | | | | | | | | | | | | | | | | |
| 3 | | | | | | | | | | | | | | | | | | | | | | | |
| 4 | | | | | | | | | | | | | | | | | | | | | | | |
| 5 | | | | | | | | | | | | | | | | | | | | | | | |

Coarse

| | 1 1/2" | 1" | 3/4" | 1/2" | 3/8" | #4 | #8 | #200 | Comply |
|---|---|---|---|---|---|---|---|---|---|
| | 100 | 95-100 | | 25-60 | | 0-10 | 0-5 | 0-1.5 | Y/N |
| CFC1 | 100 | 99 | 69 | 31 | 16 | 3.1 | 2.1 | 1.6 | Y |
| | | | | | | | | | |
| | | | | | | | | | |

| Conc. Treatment | (X) | lb / cy |
|---|---|---|
| Ice | | |
| Heated Water | | |
| Heated Materials | | |

| | Batched Today | Week | Total To Date |
|---|---|---|---|
| Check One (X) | | X | |
| Concrete (CY): | | 39.50 | 39.50 |
| Cement (tons): | | 16.29 | 16.29 |

Intermediate

| | 1 1/2" | 1" | 3/4" | 1/2" | 3/8" | #4 | #8 | #200 | Comply |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | NA |
| | | | | | | | | | NA |
| | | | | | | | | | NA |

| | Brand / Source | Rate | Lot Number |
|---|---|---|---|
| Air Entraining: | PAVE AIR 90 / MAST BLD | 13 OZ/YD | 86977-2 |
| Water Reducer: | | | |
| Retarder: | | | |
| Calcium Chloride: | | | |
| Superplasticizer: | | | |

Fine

| | 1/2" | 3/8" | #4 | #8 | #16 | #30 | #50 | #100 | #200 | Comply |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 100 | 90-100 | 70-100 | | 10-60 | | | 0-1.5 | Y/N |
| CFF1 | | 100 | 97 | 81 | 61 | 30 | 9 | 1.4 | 0.8 | Y |
| | | | | | | | | | | |
| | | | | | | | | | | |

| | Type | Sp. Gr. | Source |
|---|---|---|---|
| Cement: | 1 | 3.14 | HOLCIM PCO301 |
| Fly Ash: | | | |
| 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 | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |

| | Source | T-203 A # | Grad. No. |
|---|---|---|---|
| Coarse: | KNIFE RIVER | 99002 | 3 |
| Intermediate: | | | |
| Fine: | MARTIN M RASH | 35522 | 1 |

Remarks: COARSE AGG GOOD FOR 2.5 ON 200 SCREEN

C.P.I.: JOHN DOE CI 000

Monitor: JANE SMITH NE 000

Distribution: ____ DME ____ Proj. Eng. ____ Plant

4/25/13 ver.11.07

# IOWA DOT ASPHALT PAVING DAILY PLANT REPORT

9/17/17 11:24 AM

| | | | |
|---|---|---|---|
| | 9/16/2017 | Contractor: ******* Inc. | County: Jasper |
| Active Project No.: | STPN-224-1(12)--2J-50 | Jasper RAP Stockpile ID | ABC17-030 |
| Contract ID: | 50-2241-012 | | (5.15 % AC) |
| Mix Design No.: | 1BD17-002 | | |

| | | | |
|---|---|---|---|
| Active Placement: | Surface (Travel Lane) | Report No.: | 1 |
| Mix Type: | St Surface L - 4 1/2 (HMA) | Lab Voids Target: | 4.0 |
| Active Bid Item: | 2303-1033504 ST SURF 1/2IN L-4 (HMA) | Design Gyrations: | 50 |

## UNCOMPACTED MIXTURE

| Hot Box I.D. (Theoretical %AC) | SUR09-16 (6.54%) | SUR09-16B (6.63%) | | | | |
|---|---|---|---|---|---|---|
| Date Sampled | 9/16/17 | 9/16/17 | | | | |
| Time | 9:09 AM | 10:10 AM | | | | |
| Station | 539+00 | 556+00 | | | | |
| Bar Code ID | | | | | | |
| Sample (Tons) | 356.66 | 563.00 | | | | |
| $G_{mb}$ | 2.333 | 2.339 | | | | |
| Gmb (DOT) (In) | | 2.336 | | | | |
| $G_{mm}$ | 2.415 | 2.410 | | | | |
| Gmm (DOT) (In) | | 2.405 | | | | |
| $P_a$ (%) | 3.4 | 2.9 | | | | |
| $P_a$ (%) (DOT) | | 2.9 | | | | |
| | | | Avg $G_{mb}$ | Avg $G_{mm}$ | Avg Pa (%) | |
| | | | 2.336 | 2.413 | 3.2 | |

## GRADATION (%Passing)

☐ Use DOT

| Sieve | Specs | CF0916-A | | | Avg | District |
|---|---|---|---|---|---|---|
| 1 in. | 100 | 100.0 | | | 100.0 | |
| 3/4 in. | 100 | 100.0 | | | 100.0 | |
| 1/2 in. | 87-100(94) | 96.0 | | | 96.0 | |
| 3/8 in. | 83-97(90) | 89.0 | | | 89.0 | |
| * #4 | 60-74(67) | 66.0 | | | 66.0 | |
| * Dev | ± 7.0 | **-1.0** | | | **-1.0** | |
| *#8 | 44-54(49) | 51.0 | | | 51.0 | |
| *Dev | ± 5.0 | **2.0** | | | **2.0** | |
| #16 | | 39.0 | | | 39.0 | |
| *#30 | 21-29(25) | 28.0 | | | 28.0 | |
| * Dev | ± 4.0 | **3.0** | | | **3.0** | |
| #50 | | 12.0 | | | 12.0 | |
| #100 | | 6.8 | | | 6.8 | |
| *#200 | 2.4-6.4(4.4) | 5.5 | | | 5.5 | |
| *Dev | ± 2.0 | **1.1** | | | **1.1** | |
| Gradation Compliance? | | Yes | | | Yes | |
| DBR | Sugg 0.6 - 1.4 | 1.02 | | | 1.02 | |
| % +4 Type 4 | | 77.9 | | | 77.9 | |
| % +4 Type 3 | | | | | 0.0 | |
| (+4/-4) Type 2 | | 00.0/00.0 | | | 00.0/00.0 | |

## BINDER

| | Target | Actual | Spec | Comply? |
|---|---|---|---|---|
| % Added Binder | 5.30 | 5.40 | N/A | |
| % Total Binder | 6.30 | 6.58 | 6.00-6.60 | Yes |
| % RAP | 20.00 | 24.28% | ≤100% | Yes |
| % RAS | | | | |
| % Binder Replacement | 15.48% | 17.97% | ≤ 30% | Yes |
| PG Grade | 58-28V | | 58-28V | Yes |
| Gb: 1.03115 | Gsb: 2.580 | | Pbe (%): 5.39 | |

## COMPACTED JOINT

| Core # | Station | Joint ID | $G_{mb}$ |
|---|---|---|---|
| 1 | | | |
| 2 | | | |
| 3 | | | |
| | | Average Joint $G_{mb}$ | |
| | | Average Mat $G_{mb}$ | 2.260 |
| | | % Mat Density | |

**For information Only**

Joint Length, ft

Unit Price Adjustment ($/ft)

Joint Price Adjustment =

**USE D.O.T. RESULTS**
**(Enter an 'X')**

**TEST STRIP**
**(Enter an "X")**

| FILM THICKNESS (FT) [8.0-15.0] | |
|---|---|
| FT, µm | **9.1** |
| Price Adjustment | $0.00 |

| Gyratory VMA | |
|---|---|
| VMA, % | **15.4** |

## QUANTITY FOR PAYMENT

| | |
|---|---|
| Mix Unit Price ($/ton) | $45.65 |
| Binder Unit Price ($/ton) | $490.00 |
| Tons of Mix on Road | 792.91 |
| Tons to Other Bid Item(s) | 92.18 |
| Tons of Binder | 52.18 |
| Tons of Waste | 35.00 |
| Tons of Binder to Date | 52.18 |
| Tons of Mix to Date | 792.91 |

## PLACEMENT RECORD

| From Station | To Station | Lane | Width (ft) |
|---|---|---|---|
| 513+41 | 576+00 | SB/WB Drive Ln | 14 |

Certified Tech: ****** ****** Cert. No. *****

Certified Tech: ****** ****** Cert. No. *****

Distribution: ____ Dist. Materials ____ Proj. Engineer ____ Contractor

## COMPACTED MAT

| Core | Date of Placement | Station | CL Reference | W1 Dry (g) | W2 in H20 (g) | W3 Wet (g) | $G_{mb}$ | % of Gmm | $P_a$ (%) | Thickness (in.) |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 9/16/2017 | 519+82 | 12.3 S\W Drv | 1,435.3 | 798.9 | 1,436.4 | 2.251 | 93.3 | 6.7 | 1.50 |
| 2 | 9/16/2017 | 528+91 | 3.2 S\W Drv | 1,265.6 | 702.2 | 1,266.5 | 2.243 | 93.0 | 7.0 | 1.25 |
| 3 | 9/16/2017 | 529+06 | 12.3 S\W Drv | 1,313.7 | 733.6 | 1,314.9 | 2.260 | 93.7 | 6.3 | 1.25 |
| 4 | 9/16/2017 | 539+64 | 9.2 S\W Drv | 1,424.5 | 802.8 | 1,425.4 | 2.288 | 94.8 | 5.2 | 1.50 |
| 5 | 9/16/2017 | 545+93 | 6.5 S\W Drv | 1,377.7 | 765.3 | 1,378.9 | 2.245 | 93.0 | 7.0 | 1.50 |
| 6 | 9/16/2017 | 559+83 | 3.8 S\W Drv | 1,611.3 | 898.0 | 1,612.7 | 2.255 | 93.5 | 6.5 | 1.75 |
| 7 | 9/16/2017 | 566+69 | 11.7 S\W Drv | 1,259.5 | 704.0 | 1,260.6 | 2.263 | 93.8 | 6.2 | 1.25 |
| 8 | 9/16/2017 | 569+42 | 7.7 S\W Drv | 1,455.9 | 815.9 | 1,457.1 | 2.271 | 94.1 | 5.9 | 1.50 |

Course Placed: Surface (Travel Lane) Thickness QI: 0.88

Intended Lift Thickness: 1.50 Avg. Mat Density: 2.260

Date Placed: 09/16/17 Avg. % of Gmm: 93.650

Test Date/By: 09/17/17 Tina Durnin Avg. % Field Voids: 6.35

$$\text{Q.I. (lower)} = \frac{(0.965 \times 2.413) - 2.260}{0.015} = \mathbf{4.57} \rightarrow \text{PWL (lower)} = 100.0$$

$$\text{Q.I. (upper)} = \frac{2.260 - (0.915 \times 2.413)}{0.015} = \mathbf{3.47} \rightarrow \text{PWL (upper)} = 100.0$$

$$\text{PWL (total)} = 100.0 + 100.0 - 100.0 = \mathbf{100.0}$$

**Pay Factor = 1.040**

Tons of Mix for PWL Field Voids Analysis (00.00 deducted)= 792.91 Field Voids Incentive = $1,447.85

## TEMPERATURE, °F

| Time | 7:00 | 9:00 | 11:00 | 1:00 | 3:00 | 5:00 | 7:00 | Spec | Comply? |
|---|---|---|---|---|---|---|---|---|---|
| Air Temp | 68 | 74 | 82 | | | | | | |
| Binder Temp | 300 | 302 | 305 | | | | | 260-330 °F | Yes |
| Plant Temp | 322 | 319 | 324 | | | | | 245-330 °F | Yes |
| Mat Temp | 320 | 320 | 310 | | | | | 245-330 °F | Yes |

☐ Break Down
☐ Rain Out

☐ Re-start after mandatory shutdown

Mix Change Information (when changes are made to start the day, identify them on previous day's report):

| | Old Target | New Target | Tons | Agg | Initial % | New % | Agg | Initia | New % |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | |

Comments:

Martin Marietta

**26125 Sully Mine**
**5046 E 132nd Street S**
**Lynnville, IA 50153**

**Ticket 33025017**

| Date | DEL/PU/BUY | Dispatch | Scale |
|---|---|---|---|
| 5/10/2022 | P | | 1 |

| Time Due | Time In | Time Out | Silo # |
|---|---|---|---|
| | 0:00 | 6:30 | |

**Vehicle** IF7995 - 40 KEYSTONE - WAYNE
**Carrier** 602830 - JORDISON CONST INC DBA KEYSTONE TRUCKING

| Customer No | Order No | PO No | Product | Shipped Today | Job To Date |
|---|---|---|---|---|---|
| 409789 | 60185445 | | 0678 - CLASS 3I 57 | 2 LDS (51.97 Ton) | 9,372.22 Ton |

**Ship To** 409789 - LIBERTY READY MIX
DIXON PLANT
SEASON PRICES

**Dest ID**
**Instruct**

| | | LBS | TONS | METRIC |
|---|---|---|---|---|
| GROSS | | 79,440 | 39.72 | 36.03 |
| TARE | * | 27,480 | 13.74 | 12.46 |
| NET | | 51,960 | 25.98 | 23.57 |

* P. T.

**Weigh Master** BRENDA L. **Seal #:**

This is to certify the material herein described meets the applicable contract specs & requirements A50002 GRAD # 3 BEDS 37-41 CLASS 3i /ALSO 1" PIPE BEDDING

**Signature of Receiving Agent** | **Customer**

Martin Marietta Standard Terms and Conditions apply (copy available at Site Office).

**WARNING**
Read important health information on reverse.

**PRECAUCIÓN**
Léase la información importante para la salud en el reverso.

**WENDLING**
CRUSHED STONE - SAND - GRAVEL - ASPHALT

Office Phone 563-659-9181
Location Phone 319-362-5317

## Ticket 5508436

**Location: 044 - CR SOUTH-A57028**
4951 EDGEWOOD RD SW CEDAR RAPIDS, IA 52404

**Carrier** PELLING - LL PELLING
**Vehicle** 507-PELL **Hired By WQI:** ☐ Yes ☑ No
**Customer** 12560 - LL PELLING COMPANY INC
**Order** 11803 - NHSX-030-7(219)--3H-57 US 30 HMA RESURFACING

| Time | Date |
|---|---|
| 10:39:00 AM | 7/11/2024 |

| | Qty | Amount |
|---|---|---|
| Product | 25.61 Tons | |
| Tax | | |
| Total | | |

**Product** 0108.4
**Product Desc.** Granular Shoulder Type B #11

**Deliver**

**Order PO #** 53891
**PO #**

| | Pounds | Tons |
|---|---|---|
| Gross | 77,600 | 38.80 |
| Tare | 26,380 | 13.19 |
| Net | 51,220 | 25.61 |

| | Today |
|---|---|
| Loads | 35 |
| Qty | 845.77 |

QUARRY AGLIME
"Iowa Secretary of Agriculture Certified lbs ECCE per ton"

THIS IS TO CERTIFY THAT THE MATERIAL HEREIN DESCRIBED MEETS THE APPLICABLE CONTRACT, SPECIFICATIONS

All material hauled from this plant at an agreed rate per ton is preformed by independent trucking contractors who assume all liability for compensation, public liability and property damage insurance; also, all social security taxes, withholding taxes, and any other texes assessed. Drivers, other than owner-driver, will be employed by the trucking contractor.

**Initials** S.P. **Weighmaster** S.P.

# BLANK WORKSHEETS

# Fineness Modulus Calculation
# (Fine Aggregate for PCC)
# AASHTO T27-93

Determine the cumulative percents retained for each sieve, starting with the largest sieve retaining any material, through the #100 sieve. Add the cumulative percents retained and divide that sum by 100. results are reported to the nearest 0.01 (one-hundreth).

| **Sieves** | **Percent Retained** | **Cumulative Percent Retained** |
|---|---|---|
| **⅜"** | | |
| **#4** | | |
| **#8** | | |
| **#16** | | |
| **#30** | | |
| **#50** | | |
| **#100** | | |

**Total Cumulative Percent =** | |
|---|
| |

**Fineness Modulus =**

Form 820180ex

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

| | | | |
|---|---|---|---|
| Original Dry Weight: | | Total Minus No. 4 (W1): | |
| Dry Weight Washed: | | Reduced Minus No. 4 (W2) | |
| Washing Loss: | | Conversion Factor: W1 ÷ W2 | |
| | | Calculated Weight (A)=Conversion Factor x (B) | |

| Sieve Size | Reduced Minus No. 4 | Total or Calc. Weight Retd. | % Retained | % Passing | Specs. |
|---|---|---|---|---|---|
| 1½” | | | | | |
| 1” | | | | | |
| ¾” | | | | | |
| ½” | | | | | |
| ⅜” | | | | | |
| No.4 | | | | | |
| No. 8 | (B) | (A) | | | |
| No.16 | (B) | (A) | | | |
| No. 30 | (B) | (A) | | | |
| No. 50 | (B) | (A) | | | |
| No. 100 | (B) | (A) | | | |
| No. 200 | (B) | (A) | | | |
| Washing Loss | | | | | |
| Pan | (B) | (A) | | | |
| Total | | | | | |
| Accuracy Check | | | | | |

***Wash Sample***

| | |
|---|---|
| Original Dry Weight: | |
| Dry Weight Washed: | |
| Washing Loss: | |

| Sieve Size | Weight Retd. | % Retd. | % Passing | Specs. |
|---|---|---|---|---|
| No. 200 | | | | |
| Washing Loss | | | | |
| Pan | | | | |

| | |
|---|---|
| Date Reported: | Cert No.: |
| Tested By: | |

NOTE: No more than 200 grams should be retained on the 8” sieves. No more than 850 grams should be retained on the 12” No. 4 sieve, and a maximum of 450 grams on the No. 8 and smaller sieves.

Comments: ____________________________________________

Form 820180ex

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

| | | | |
|---|---|---|---|
| Original Dry Weight: | | Total Minus No. 4 (W1): | |
| Dry Weight Washed: | | Reduced Minus No. 4 (W2) | |
| Washing Loss: | | Conversion Factor: W1 ÷ W2 | |
| | | Calculated Weight (A)=Conversion Factor x (B) | |

| Sieve Size | Reduced Minus No. 4 | Total or Calc. Weight Retd. | % Retained | % Passing | Specs. |
|---|---|---|---|---|---|
| 1½" | | | | | |
| 1" | | | | | |
| ¾" | | | | | |
| ½" | | | | | |
| ⅜" | | | | | |
| No.4 | | | | | |
| No. 8 | (B) | (A) | | | |
| No.16 | (B) | (A) | | | |
| No. 30 | (B) | (A) | | | |
| No. 50 | (B) | (A) | | | |
| No. 100 | (B) | (A) | | | |
| No. 200 | (B) | (A) | | | |
| Washing Loss | | | | | |
| Pan | (B) | (A) | | | |
| Total | | | | | |
| Accuracy Check | | | | | |

***Wash Sample***

| | |
|---|---|
| Original Dry Weight: | |
| Dry Weight Washed: | |
| Washing Loss: | |

| Sieve Size | Weight Retd. | % Retd. | % Passing | Specs. |
|---|---|---|---|---|
| No. 200 | | | | |
| Washing Loss | | | | |
| Pan | | | | |

| | | |
|---|---|---|
| Date Reported: | Cert No.: | |
| Tested By: | | |

NOTE: No more than 200 grams should be retained on the 8" sieves. No more than 850 grams should be retained on the 12" No. 4 sieve, and a maximum of 450 grams on the No. 8 and smaller sieves.

Comments: ____________________________________________

Form 820180ex

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

| | | | |
|---|---|---|---|
| Original Dry Weight: | | Total Minus No. 4 (W1): | |
| Dry Weight Washed: | | Reduced Minus No. 4 (W2) | |
| Washing Loss: | | Conversion Factor: W1 ÷ W2 | |
| | | Calculated Weight (A)=Conversion Factor x (B) | |

| Sieve Size | Reduced Minus No. 4 | Total or Calc. Weight Retd. | % Retained | % Passing | Specs. |
|---|---|---|---|---|---|
| 1½” | | | | | |
| 1” | | | | | |
| ¾” | | | | | |
| ½” | | | | | |
| ⅜” | | | | | |
| No.4 | | | | | |
| No. 8 | (B) | (A) | | | |
| No.16 | (B) | (A) | | | |
| No. 30 | (B) | (A) | | | |
| No. 50 | (B) | (A) | | | |
| No. 100 | (B) | (A) | | | |
| No. 200 | (B) | (A) | | | |
| Washing Loss | | | | | |
| Pan | (B) | (A) | | | |
| Total | | | | | |
| Accuracy Check | | | | | |

| | | | | |
|---|---|---|---|---|
| ***Wash Sample*** | Original Dry Weight: | | | |
| | Dry Weight Washed: | | | |
| | Washing Loss: | | | |
| Sieve Size | Weight Retd. | % Retd. | % Passing | Specs. |
| No. 200 | | | | |
| Washing Loss | | | | |
| Pan | | | | |

| | | |
|---|---|---|
| Date Reported: | Cert No.: | |
| Tested By: | | |

NOTE: No more than 200 grams should be retained on the 8” sieves. No more than 850 grams should be retained on the 12” No. 4 sieve, and a maximum of 450 grams on the No. 8 and smaller sieves.

Comments: ______________________________________________

Form 820180ex

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

| | | | |
|---|---|---|---|
| Original Dry Weight: | | Total Minus No. 4 (W1): | |
| Dry Weight Washed: | | Reduced Minus No. 4 (W2) | |
| Washing Loss: | | Conversion Factor: W1 ÷ W2 | |
| | | Calculated Weight (A)=Conversion Factor x (B) | |

| Sieve Size | Reduced Minus No. 4 | Total or Calc. Weight Retd. | % Retained | % Passing | Specs. |
|---|---|---|---|---|---|
| 1½" | | | | | |
| 1" | | | | | |
| ¾" | | | | | |
| ½" | | | | | |
| ⅜" | | | | | |
| No.4 | | | | | |
| No. 8 | (B) | (A) | | | |
| No.16 | (B) | (A) | | | |
| No. 30 | (B) | (A) | | | |
| No. 50 | (B) | (A) | | | |
| No. 100 | (B) | (A) | | | |
| No. 200 | (B) | (A) | | | |
| Washing Loss | | | | | |
| Pan | (B) | (A) | | | |
| Total | | | | | |
| Accuracy Check | | | | | |

| ***Wash Sample*** | | | | |
|---|---|---|---|---|
| | Original Dry Weight: | | | |
| | Dry Weight Washed: | | | |
| | Washing Loss: | | | |
| Sieve Size | Weight Retd. | % Retd. | % Passing | Specs. |
| No. 200 | | | | |
| Washing Loss | | | | |
| Pan | | | | |

| | | |
|---|---|---|
| Date Reported: | Cert No.: | |
| Tested By: | | |

NOTE: No more than 200 grams should be retained on the 8" sieves. No more than 850 grams should be retained on the 12" No. 4 sieve, and a maximum of 450 grams on the No. 8 and smaller sieves.

Comments: ______________________________________________

Form 820180ex

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

| | | | |
|---|---|---|---|
| Original Dry Weight: | | Total Minus No. 4 (W1): | |
| Dry Weight Washed: | | Reduced Minus No. 4 (W2) | |
| Washing Loss: | | Conversion Factor: W1 ÷ W2 | |
| | | Calculated Weight (A)=Conversion Factor x (B) | |

| Sieve Size | Reduced Minus No. 4 | Total or Calc. Weight Retd. | % Retained | % Passing | Specs. |
|---|---|---|---|---|---|
| 1½” | | | | | |
| 1” | | | | | |
| ¾” | | | | | |
| ½” | | | | | |
| ⅜” | | | | | |
| No.4 | | | | | |
| No. 8 | (B) | (A) | | | |
| No.16 | (B) | (A) | | | |
| No. 30 | (B) | (A) | | | |
| No. 50 | (B) | (A) | | | |
| No. 100 | (B) | (A) | | | |
| No. 200 | (B) | (A) | | | |
| Washing Loss | | | | | |
| Pan | (B) | (A) | | | |
| Total | | | | | |
| Accuracy Check | | | | | |

| ***Wash Sample*** | | | | |
|---|---|---|---|---|
| | Original Dry Weight: | | | |
| | Dry Weight Washed: | | | |
| | Washing Loss: | | | |
| Sieve Size | Weight Retd. | % Retd. | % Passing | Specs. |
| No. 200 | | | | |
| Washing Loss | | | | |
| Pan | | | | |

| | | |
|---|---|---|
| Date Reported: | | Cert No.: |
| Tested By: | | |

NOTE: No more than 200 grams should be retained on the 8” sieves. No more than 850 grams should be retained on the 12” No. 4 sieve, and a maximum of 450 grams on the No. 8 and smaller sieves.

Comments: ____________________________________________

Form 820180ex

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

| | | | |
|---|---|---|---|
| Original Dry Weight: | | Total Minus No. 4 (W1): | |
| Dry Weight Washed: | | Reduced Minus No. 4 (W2) | |
| Washing Loss: | | Conversion Factor: W1 ÷ W2 | |
| | | Calculated Weight (A)=Conversion Factor x (B) | |

| Sieve Size | Reduced Minus No. 4 | Total or Calc. Weight Retd. | % Retained | % Passing | Specs. |
|---|---|---|---|---|---|
| 1½” | | | | | |
| 1” | | | | | |
| ¾” | | | | | |
| ½” | | | | | |
| ⅜” | | | | | |
| No.4 | | | | | |
| No. 8 | (B) | (A) | | | |
| No.16 | (B) | (A) | | | |
| No. 30 | (B) | (A) | | | |
| No. 50 | (B) | (A) | | | |
| No. 100 | (B) | (A) | | | |
| No. 200 | (B) | (A) | | | |
| Washing Loss | | | | | |
| Pan | (B) | (A) | | | |
| Total | | | | | |
| Accuracy Check | | | | | |

***Wash Sample***

| | | | | |
|---|---|---|---|---|
| | Original Dry Weight: | | | |
| | Dry Weight Washed: | | | |
| | Washing Loss: | | | |
| Sieve Size | Weight Retd. | % Retd. | % Passing | Specs. |
| No. 200 | | | | |
| Washing Loss | | | | |
| Pan | | | | |

| | | |
|---|---|---|
| Date Reported: | Cert No.: | |
| Tested By: | | |

NOTE: No more than 200 grams should be retained on the 8” sieves. No more than 850 grams should be retained on the 12” No. 4 sieve, and a maximum of 450 grams on the No. 8 and smaller sieves.

Comments: ______________________________________________

Form 820180ex

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

| | | | |
|---|---|---|---|
| Original Dry Weight: | | Total Minus No. 4 (W1): | |
| Dry Weight Washed: | | Reduced Minus No. 4 (W2) | |
| Washing Loss: | | Conversion Factor: W1 ÷ W2 | |
| | | Calculated Weight (A)=Conversion Factor x (B) | |

| Sieve Size | Reduced Minus No. 4 | Total or Calc. Weight Retd. | % Retained | % Passing | Specs. |
|---|---|---|---|---|---|
| 1½" | | | | | |
| 1" | | | | | |
| ¾" | | | | | |
| ½" | | | | | |
| ⅜" | | | | | |
| No.4 | | | | | |
| No. 8 | (B) | (A) | | | |
| No.16 | (B) | (A) | | | |
| No. 30 | (B) | (A) | | | |
| No. 50 | (B) | (A) | | | |
| No. 100 | (B) | (A) | | | |
| No. 200 | (B) | (A) | | | |
| Washing Loss | | | | | |
| Pan | (B) | (A) | | | |
| Total | | | | | |
| Accuracy Check | | | | | |

***Wash Sample***

| | |
|---|---|
| Original Dry Weight: | |
| Dry Weight Washed: | |
| Washing Loss: | |

| Sieve Size | Weight Retd. | % Retd. | % Passing | Specs. |
|---|---|---|---|---|
| No. 200 | | | | |
| Washing Loss | | | | |
| Pan | | | | |

| | | |
|---|---|---|
| Date Reported: | Cert No.: | |
| Tested By: | | |

NOTE: No more than 200 grams should be retained on the 8" sieves. No more than 850 grams should be retained on the 12" No. 4 sieve, and a maximum of 450 grams on the No. 8 and smaller sieves.

Comments: ______________________________________________

Form 820180ex

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

| | | | |
|---|---|---|---|
| Original Dry Weight: | | Total Minus No. 4 (W1): | |
| Dry Weight Washed: | | Reduced Minus No. 4 (W2) | |
| Washing Loss: | | Conversion Factor: W1 ÷ W2 | |
| | | Calculated Weight (A)=Conversion Factor x (B) | |

| Sieve Size | Reduced Minus No. 4 | Total or Calc. Weight Retd. | % Retained | % Passing | Specs. |
|---|---|---|---|---|---|
| 1½” | | | | | |
| 1” | | | | | |
| ¾” | | | | | |
| ½” | | | | | |
| ⅜” | | | | | |
| No.4 | | | | | |
| No. 8 | (B) | (A) | | | |
| No.16 | (B) | (A) | | | |
| No. 30 | (B) | (A) | | | |
| No. 50 | (B) | (A) | | | |
| No. 100 | (B) | (A) | | | |
| No. 200 | (B) | (A) | | | |
| Washing Loss | | | | | |
| Pan | (B) | (A) | | | |
| Total | | | | | |
| Accuracy Check | | | | | |

***Wash Sample***

| | |
|---|---|
| Original Dry Weight: | |
| Dry Weight Washed: | |
| Washing Loss: | |

| Sieve Size | Weight Retd. | % Retd. | % Passing | Specs. |
|---|---|---|---|---|
| No. 200 | | | | |
| Washing Loss | | | | |
| Pan | | | | |

| | | |
|---|---|---|
| Date Reported: | Cert No.: | |
| Tested By: | | |

NOTE: No more than 200 grams should be retained on the 8” sieves. No more than 850 grams should be retained on the 12” No. 4 sieve, and a maximum of 450 grams on the No. 8 and smaller sieves.

Comments: ______________________________________________