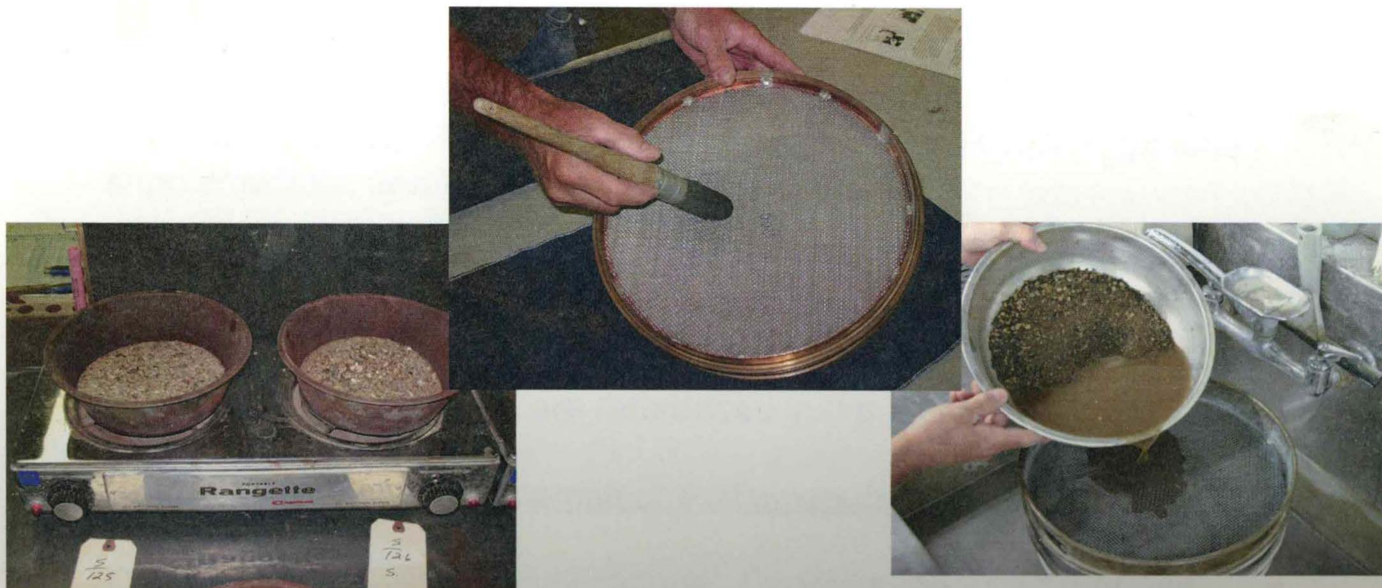
LEVEL I & II AGGREGATE INSTRUCTION TEXT



TECHNICAL TRAINING AND CERTIFICATION PROGRAM 2007 – 2008

Iowa Department of Transportation

Highway Division

Iowa DOT Websites of Interest

www.dot.state.ia.us

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

www.dot.state.ia.us/materials/index.htm

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

www.dot.state.ia.us/specifications/specdocs.htm

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.

www.dot.state.ia.us/design/index.htm

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

www.dot.state.ia.us/local_systems/publications/publications.htm

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

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."

Aggregate Textbook Summary Guide

Aggregates Defined	Section I	Definitions: • Coarse and fine aggregates • Natural aggregates • Manufactured aggregates • Synthetic aggregates • Natural sands and gravel
Aggregate Sampling	Section II	How to obtain representative aggregate samples: • Random or judgment samples (Sect. II) • Methods; stream flow, stopped belt or stockpile (fine agg)
Physical Characteristics and Various Quality Tests Performed to Determine Specification Compliance per IM 209, App. C	Section III	Section III 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. • Segregation, degradation and contamination are defined and discussed. • Moisture and specific gravity are defined and discussed.
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.
Sieve Analysis	Section V	General requirements of sieve analysis

Aggregate Reference Book Summary Guide

Field Equipment Cleaning, Calibration, Repair	IM 104	Associated costs
Project Sampling and Testing	IM 204	IM 204 is used by project inspection personnel: • Sampling/testing frequencies at time of use • Methods, documentation or test reports needed to incorporate various products into the work
Qualified Testing Laboratories	IM 208	• Basic required information, documentation and equipment • Equipment checklists
Aggregate Certification Program and Approved Aggregate Producers	IM 209	Requirements for the aggregate producer/supplier: • Sampling and testing frequencies during production (1/1500 or 1/3000 tons) • Information needed to properly certify aggregates
Aggregate Quality Requirements	IM 209 App C	• Quality (F & T tests, abrasion, etc.) specifications for aggregate products.
Gradation Specifications	IM 209 App D	• Iowa DOT standard gradation limits in terms of percent passing. • HMA and PCC mix design gradation limits are determined by the contractor and supplied to the producer on 955's.
Iowa DOT Certification Programs	IM 213	Requirements for the various certification programs required by Iowa DOT. Training and recertification procedures: Iowa and Federal Codes; Unsatisfactory Performance Notice
Guidelines for Verifying Correlation Test Results	IM 216	Allowed variances between two tests performed on the same product, i.e., slumps, air content, gradations, specific gravity, etc.
Aggregate Sampling Methods and Minimum Sample Size	IM 301	• Minimum field and gradation test sample sizes (IM 301)
Sieve Analysis (Gradation)	IM 302	Step instructions to determine particle size distribution (gradation) in a representative sample. • Required equipment • Sieve 'overload' restrictions • Calculations • Fineness Modulus Calculation
Fractured Face Count in Crushed Gravel (+3/8")	IM 305	Gravel granular subbase requires 30% of the + 3/8" particles have at least one fractured face determined by this test method.

Total Percent Passing the #200 Sieve by Washing & Dry Sieving	IM 306	Step instructions to determine percent passing the #200 sieve. • Restrictions on washing the entire sieve analysis sample or a separate smaller sample. • Sample sizes when determining only the amount passing the #200. • Calculations
Specific Gravity Tests on Coarse and Fine Aggregates	IM 307	Step instructions to perform specific gravity tests on either coarse or fine aggregates. Procedure "A" using a 'pycnometer', and Procedure "B" using a 'water bath.'
Free Moisture Absorption	IM 308	Step instructions to determine free moisture 'at time of use' on PCC aggregates using the pycnometer, moisture by weight loss and absorption value of coarse or fine aggregates.
Aggregate Sample Reduction	IM 336	Aggregate field sample reduction methods • Mechanical splitters for aggregates in a surface dry condition • Miniature stockpile for damp, fine aggregate only • Quartering, not recommended for coarse aggregates
Percent of Shale in Coarse or Fine Aggregate	IM 344 (Fine) IM 345 & 372 (Coarse)	Step instructions for test procedures to determine shale content in coarse or fine aggregates using Zinc chloride and visual pick.
Clay Lumps and Friable Particles	IM 368	Step instructions to perform 'clay lump' test on representative coarse aggregate samples.
Aggregate Source Locations and Basic Source Information	IM T-203	• PCC coarse aggregate durability ratings • Friction typing • Source locations and approvals alphabetized by county

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 #4 (4.75mm) or larger sieves.

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.

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 #4 (4.75mm) sieve, and be predominately retained on the #200 (75µm) 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.

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.

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.

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.

Zinc Chloride ($ZNCl_2$) – A chemical 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

Metric
g – grams
kg – kilogram = 1000grams
mm – millimeter
µm – micrometer

English
oz. - ounce
lb. - pound
T. - Ton
in. - inch
ft. – foot

^{2} - squared
^{3} - cubed

ROUNDING & DECIMALS

Rounding is uniform throughout the certification training. You would 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

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.

> *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, crushed or uncrushed, 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 75 µm (#200) 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 4.75 mm (#4) sieve as the sieve size with which to make this separation. All particles which will pass through a 4.75 mm (#4) sieve, and be predominately retained on the 75 µm (#200) sieve, are referred to as "fine aggregates." All particles which are retained on 4.75 mm (#4) or larger sieves are referred to as "coarse aggregate."

> **Aggregate Classification**
>
> **Coarse Aggregate: Any aggregate that does not pass the 4.75 mm (no. 4 sieve).**
>
> **Fine Aggregate: Any aggregate that passes the 4.75 mm (no. 4 sieve).**

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 or gravels as opposed to manufactured sands or gravels. Consequently, sand made by crushing quartzite or limestone is a natural aggregate but not a natural sand. The specifications required fine aggregates for concrete floors and pavements to be natural sands.

Aggregate Uses

Aggregates are used in portland cement concrete, asphaltic concrete, bases, subbases, granular backfills, 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 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 I.M. Volume II prepared by the Materials Office of the Highway Division.

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 listed 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 2 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 material produced 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 directly 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

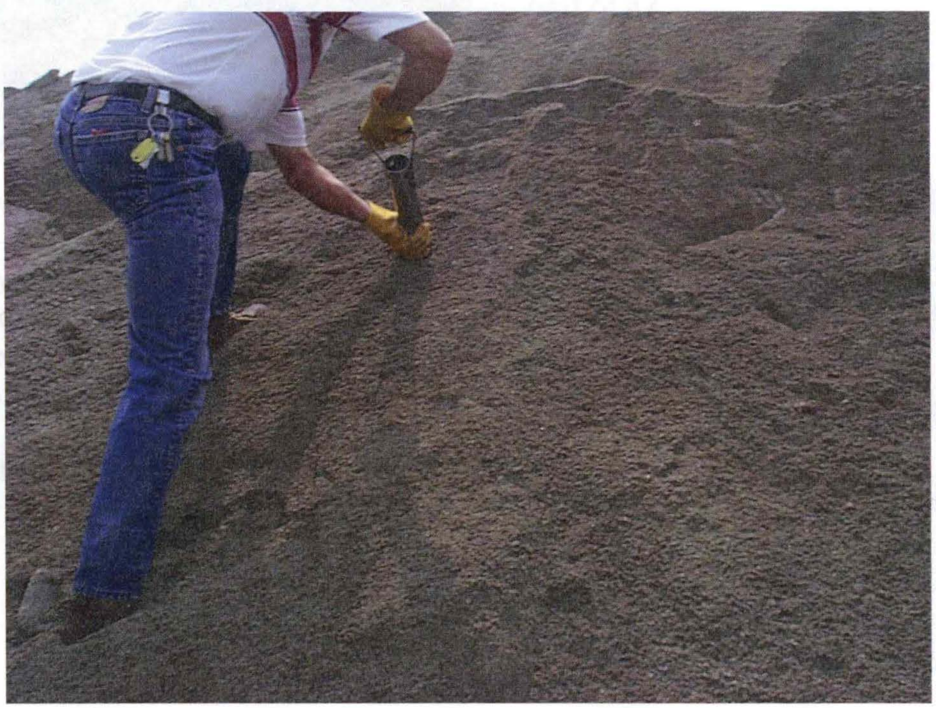
To obtain an off-the-belt sample, stop the belt, insert a template at three or more separate locations along the belt, remove all material within the template, and combine it into the field sample. In belt sampling, the ends of the template should be spaced just far enough apart to get an increment that 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. All material within each increment is removed from all three or more increments and mixed back together to make one field sample.

Streamflow Sampling

When obtaining field sample by interception of 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.

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 not to sample at the bottom of the stockpile. Stockpile sampling of coarse aggregate should be avoided. If it becomes absolutely necessary to obtain a sample from a stockpile, consult the District Materials Engineer to help you devise an adequate sampling plan.

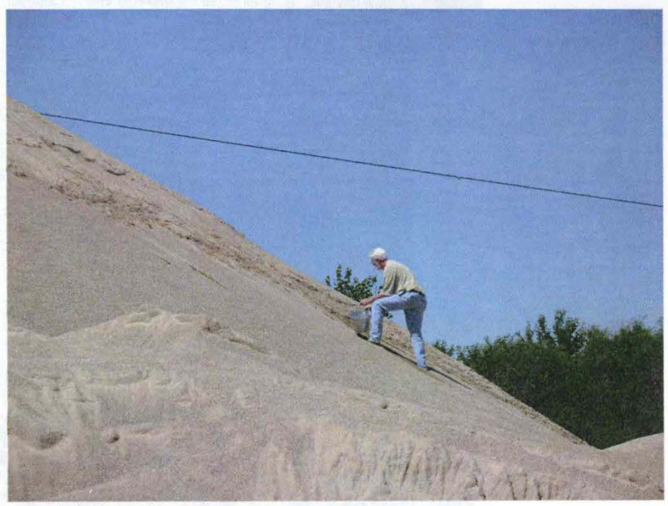


Sampling Records

It is the responsibility of the aggregate sampler to get all the necessary information to fill out report headings. This includes type of material, intended use, location of producer, source, 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. Appropriate Form 820002 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.



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.

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?
5. Do you know the proper action to take if the sample fails to meet specification requirements?

SECTION III
SAMPLE REDUCTION

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

Mechanical Splitter:
Fine, coarse or combined fine and coarse aggregate samples may be reduced using a mechanical 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

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

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. When reducing to obtain test samples, these portions may be further reduced to an appropriate minimum size. This will be further detailed in IM 336 and demonstrated in the hands-on portion of the class.

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. The 'Miniature Stockpile' method, as described in Materials IM 336, is the preferred method of reducing a damp, fine aggregate field sample into the appropriate sieve analysis test sample size.

This method will be demonstrated in the hands-on portion of the class.

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

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. Some aggregate uses require the source to be approved before production for certified material can start. 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.

Quarries

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.

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

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

As an aid identifying the various beds and/or quality units in quarry, geologic sections have been prepared for most (Figure 3.1). The various beds are identified be a number and a description. The geology 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 before, or if it isn't, that any of the new beds in 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 a simple matter 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 in knowing exactly which beds are being worked. 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 course aggregate for portland cement concrete and graded stone base.

Does the production history indicate that the finished produce will be boarder line on quality or well within the requirements?

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

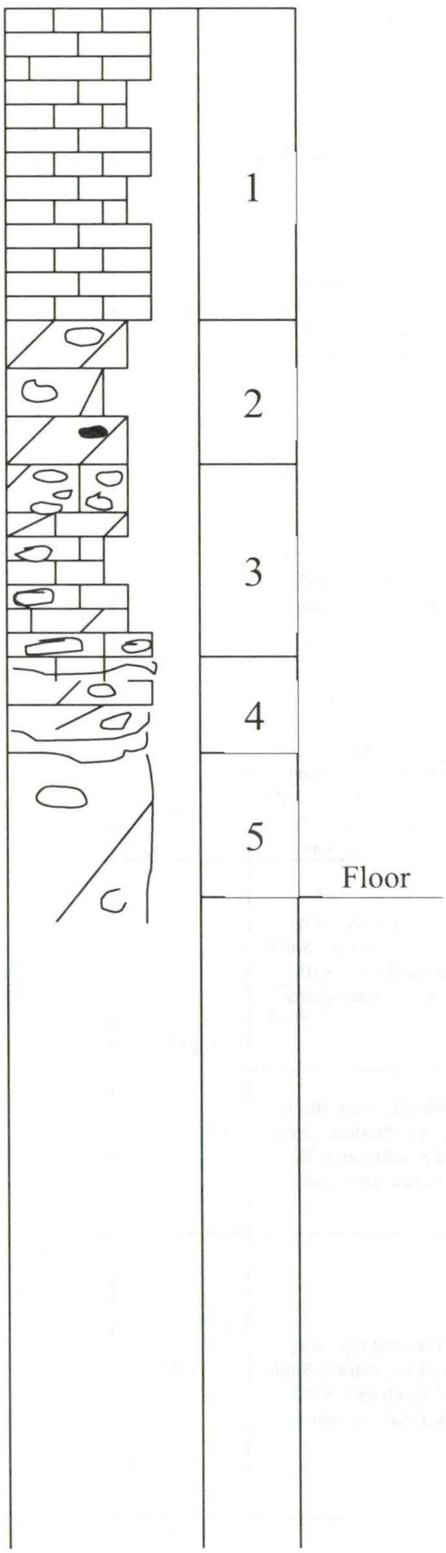
Could additional beds improve a borderline product or cause it to fail?

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

STRATIGRAPHIC COLUMN OF IOWA

SYSTEM	SERIES	GROUP	FORMATION	DESCRIPTION	THICK NESS (feet)	AGE In millions of years before present
Quaternary	Pleistocene		Wisconsinan	Loess, glacial till and interbedded sand and gravel	500'	2-3
			Illinoian			
			Kansan			
			Nebraskan			
Cretaceous		Manson	Niobrara		350'	130
		Colorado	Carlile Shale	Shale		
			Greenhorn Limestone	Limestone		
			Graneros Shale	Shale		
			Dakota	Sandstone & shale	200'	
			Windrow			
Jurassic			Fort Dodge	Gypsum, red & green shales--Webster Co. only	50'	185
Pennsylvanian	Virgilian	Wabaunsee	Wood Siding	Interbedded repeating cycles of Limestone, Shale and Sandstone, with occasional coal seams	210'	340
			Root			
			Stotler			
			Pillsbury			
			Zeandale			
			Willard Shale			
			Emporia			
			Auburn Shale			
			Bern			
			Scranton			
			Howard Limestone			
			Severy Shale			
		Shawnee	Topeka	Interbedded repeating cycles of Limestone, Shale and Sandstone, with occasional coal seams	180'	
			Calhoun Shale			
			Deer Creek			
			Tecumseh Shale			
			Lecompton			
			Kanwaka Shale			
			Oread			
		Douglas	Lawrence	Interbedded repeating cycles of Limestone, Shale and Sandstone, with occasional coal seams	110'	
			Stranger			
	Missourian	Lansing	Stanton	Interbedded repeating cycles of Limestone, Shale and Sandstone, with occasional coal seams	50'	
			Vilas Shale			
			Plattsburg			
		Kansas City	Lane Shale	Interbedded repeating cycles of Limestone, Shale and Sandstone, with occasional coal seams	255'	
			Wyandotte			
			Liberty Memorial Shale			
			Iola			
			Chanute Shale			
			Dewey			
			Nellie Bly Shale			
			Cherryvale			
		Bronson	Dennis	Interbedded repeating cycles of Limestone, Shale and Sandstone, with occasional coal seams		
			Galesburg Shale			
			Swope			
			Elm Branch Shale			
			Hertha			
			Pleasanton			
Pennsylvanian	Desmoinesian	Marmaton	Lost Branch	Interbedded repeating cycles of Limestone, Shale and Sandstone, with occasional coal seams	145'	340'
			Memorial Shale			
			Lenapah			
			Nowata Shale			
			Altamont			
			Bandera Shale			
			Pawnee			
			Labette			
			Stephens Forest			
			Morgan School Shale			
			Mouse Creek			
		Cherokee	Swede Hollow	Interbedded repeating	755'	
			Floris			

		Kalo	Cliffland Coal	cycles of Limestone, Shale and Sandstone, with occasional coal seams		
			Blackoak Coal			
			Kilbourn			
Pennsylvanian		Caseyville	Wyoming Hill Coal	Thin Limestone & Shales between coal seams		340
			Wildcat Den Coal			
Mississippian	Meramecian		Ste. Genevieve	Shale and limestone	140'	355
			St. Louis	Sandy limestone		
			Spergen	Limestone		
	Osagean	Augusta	Warsaw	Shale and dolomite	250'	
			Keokuk	Cherty dolomite and limestone		
			Burlington	Cherty dolomite and limestone		
	Kinderhookian	Sub-Augusta	Gilmore City	Limestone, oolitic	300'	
			Maynes Creek	Limestone and dolomite		
		North Hill	Chapin/Starrs Cave	Limestone	100'	
			Prospect Hill	Siltstone		
			McCraney	Limestone		
Devonian	Upper	Yellow Spring	Maple Mill	Siltstone & Shale	300'	410-415
			Aplington	Dolomite		
			Sheffield	Shale		
			Sweetland Creek	Dolomite and shale	225'	
			Lime Creek			
		U. Cedar Valley	Shell Rock	Limestone and dolomite		
			Lithograph City			
	Middle	L. Cedar Valley	Coralville	Limestone and dolomite	270'	
			Little Cedar			
		Wapsipinicon	Pinicon Ridge	Limestone & Dolomites, shales in middle		
			Spillville/Otis			
			Bertram	Dolomite		
Silurian	Upper		Gower	Dolomite, some chert	100'	425
			La Porte City	Chert and Limestone	0-100'	
			Scotch Grove	Dolomite	240-300'	
			Hopkinton	Dolomite, some chert	100-160'	
	Lower		Waucoma	Limestone, some chert	0-100'	
			Blanding	Cherty dolomite	20-100'	
			Tete des Morts	Sandy dolomite	5-25'	
			Mosalem	Cherty Shaley Dolomite	0-100'	
Ordovician	Upper		Maquoketa	Dolomite and shale	300'	475
		Galena	Dubuque	Dolomite, Limestone	320'	
			Wise Lake			
	Middle		Dunleith	Dolomite, Limestone and Shale		
			Decorah			
			Platteville	Dolomite, Limestone, Shale & Sandstone	70'	
		Ancell	Glenwood	Sandstone	50-230'	
			St. Peter			
	Lower	Prairie du Chien	Shakopee	Sand and cherty dolomite and sandstone	290'	
			Oneota			
Cambrian			Jordan	Sandstone	185'	570'
			St. Lawrence	Dolomite		
		Tunnel City	Lone Rock	Glauconitic sandstone, siltstone, shale	160'	
			Adel			
			Wonewoc	Sandstone	550'	
			Bonterre	Sandstone and shale, dolomite		
			Eau Claire			
			Mt. Simon	Sandstone		
Precambrian				Sandstones, igneous, and metamorphic rocks		+600'

Fig 3.2

Lateral Variations

Most lateral variations in bed quality are 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.

Lateral Variations Due to Weathering

These can be caused by actual compositional changes in a bed or by changes in a bed or by changes in thickness. A 60.7 mm (0.2 ft.) thick shale bed may increase to a very troublesome 304.8 mm (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, 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, becoming more shaly, 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 0.305 m to 0.607 m (1 ft. to 2 ft.) to commonly as much as 2.438 m (8 ft.) over a lateral distance of 30.48 m (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 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.

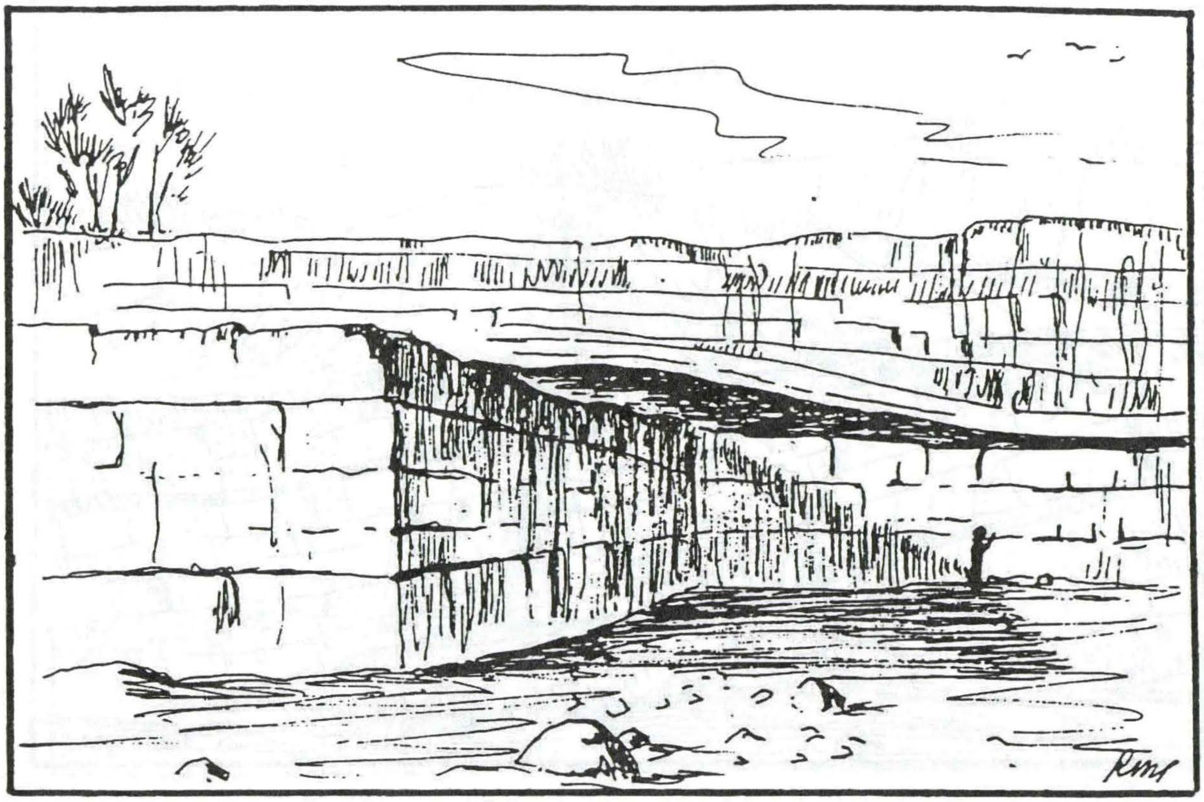


Figure 4.1

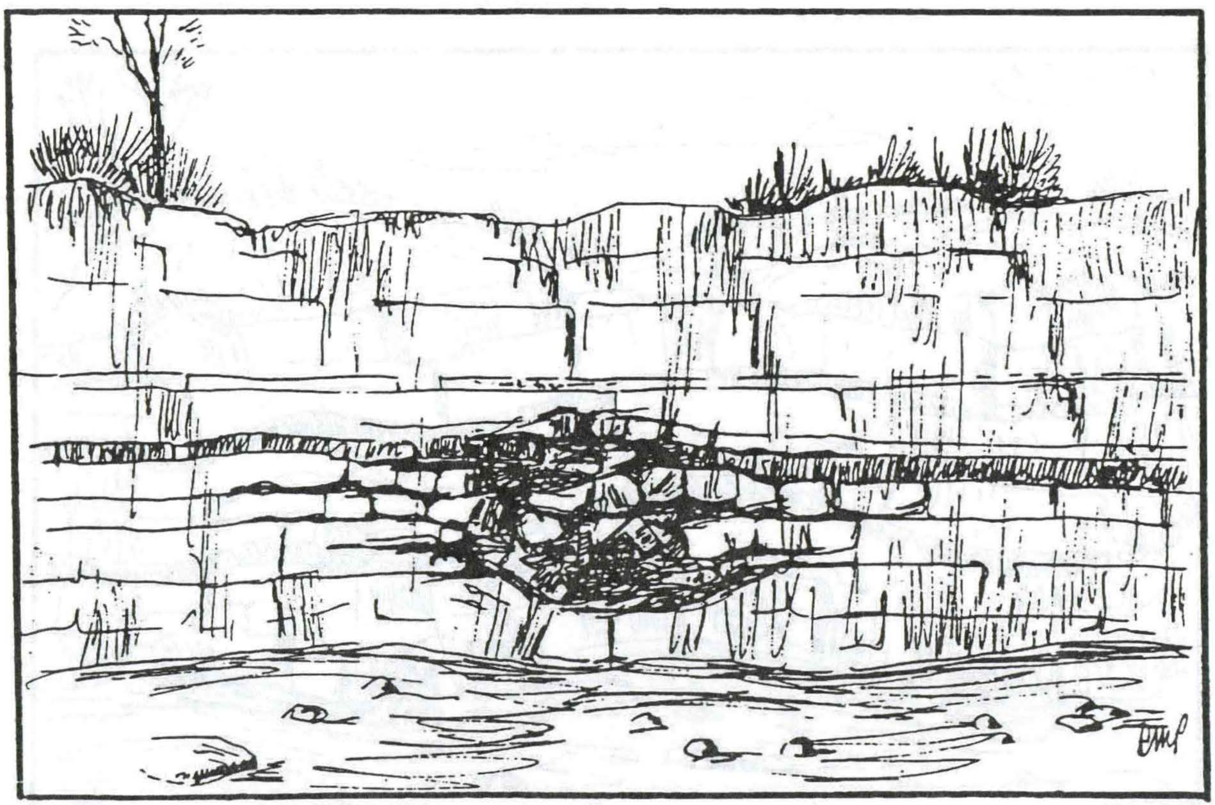


Figure 4.2

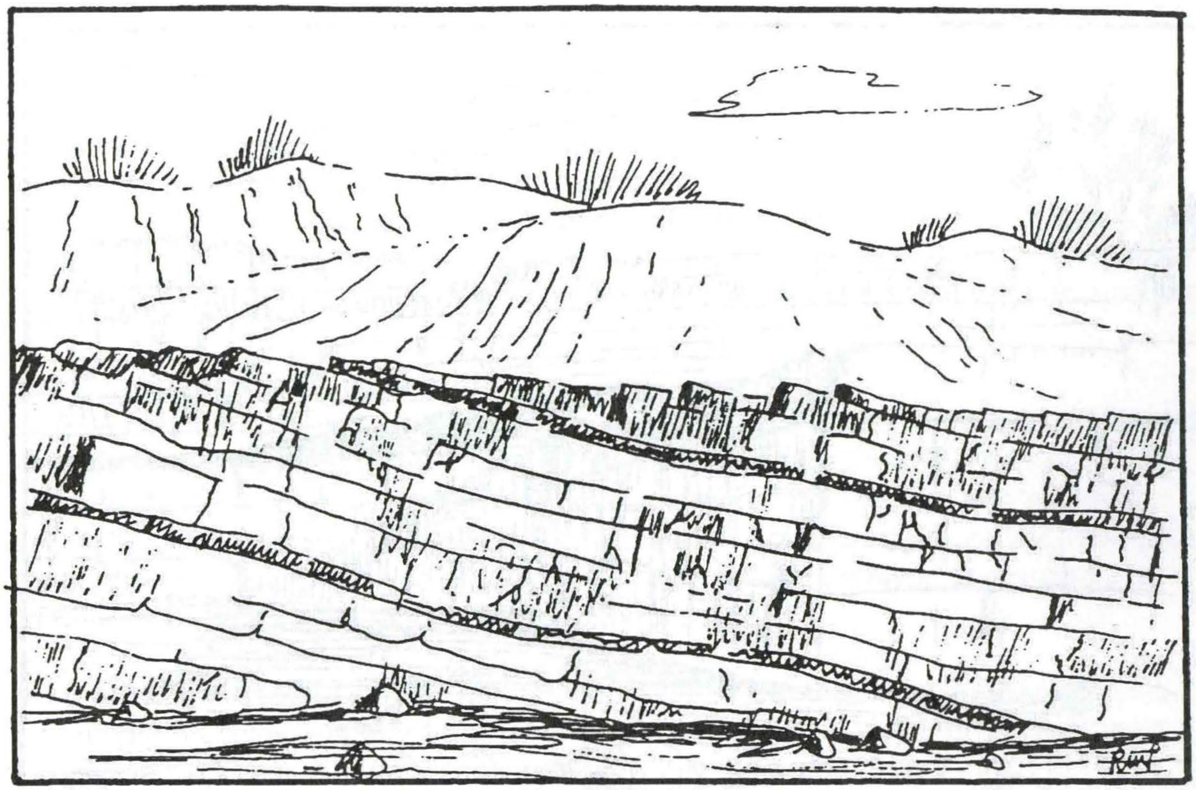


Figure 5.1

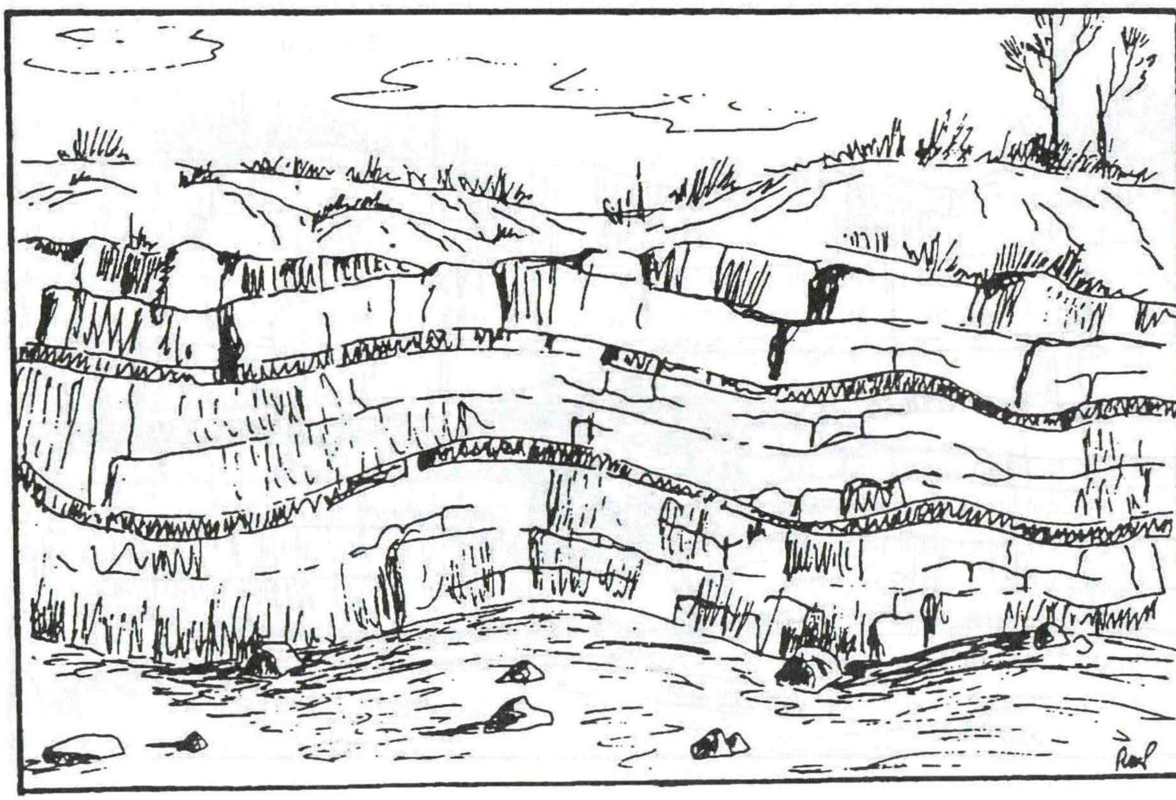


Figure 5.2

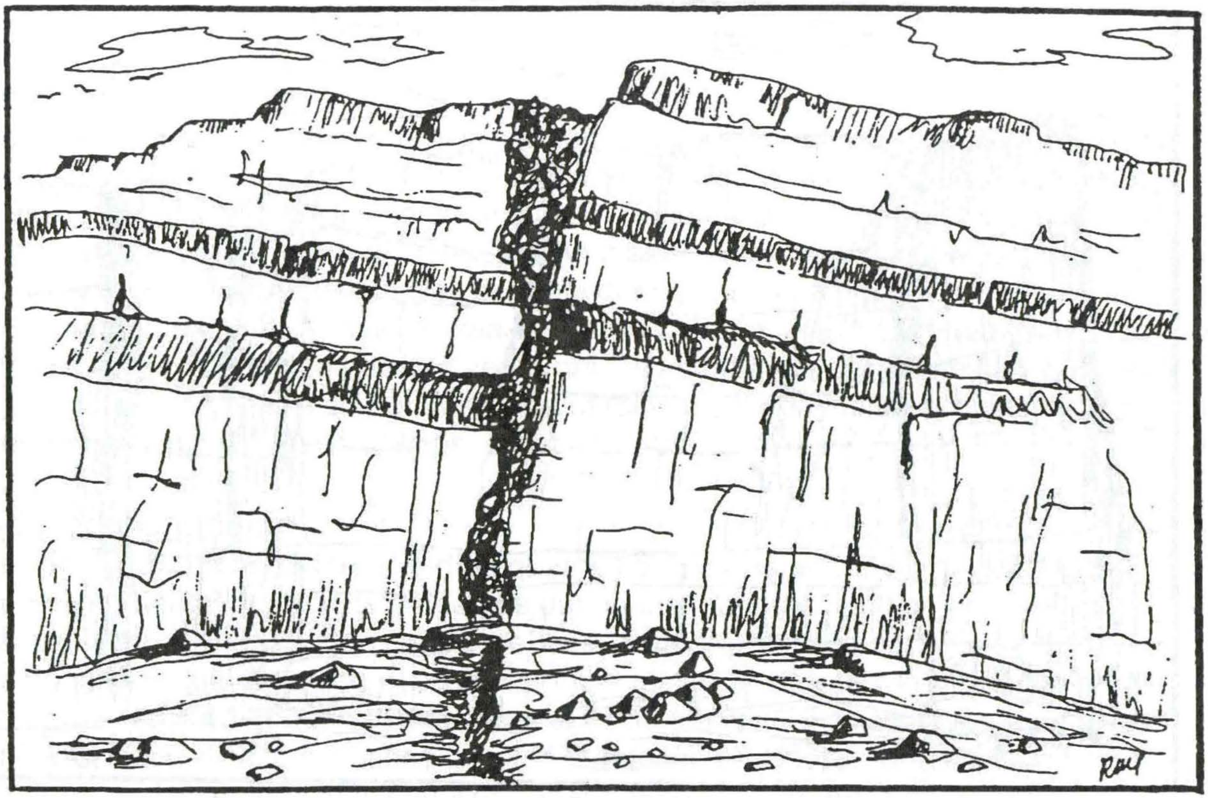


Figure 5.3

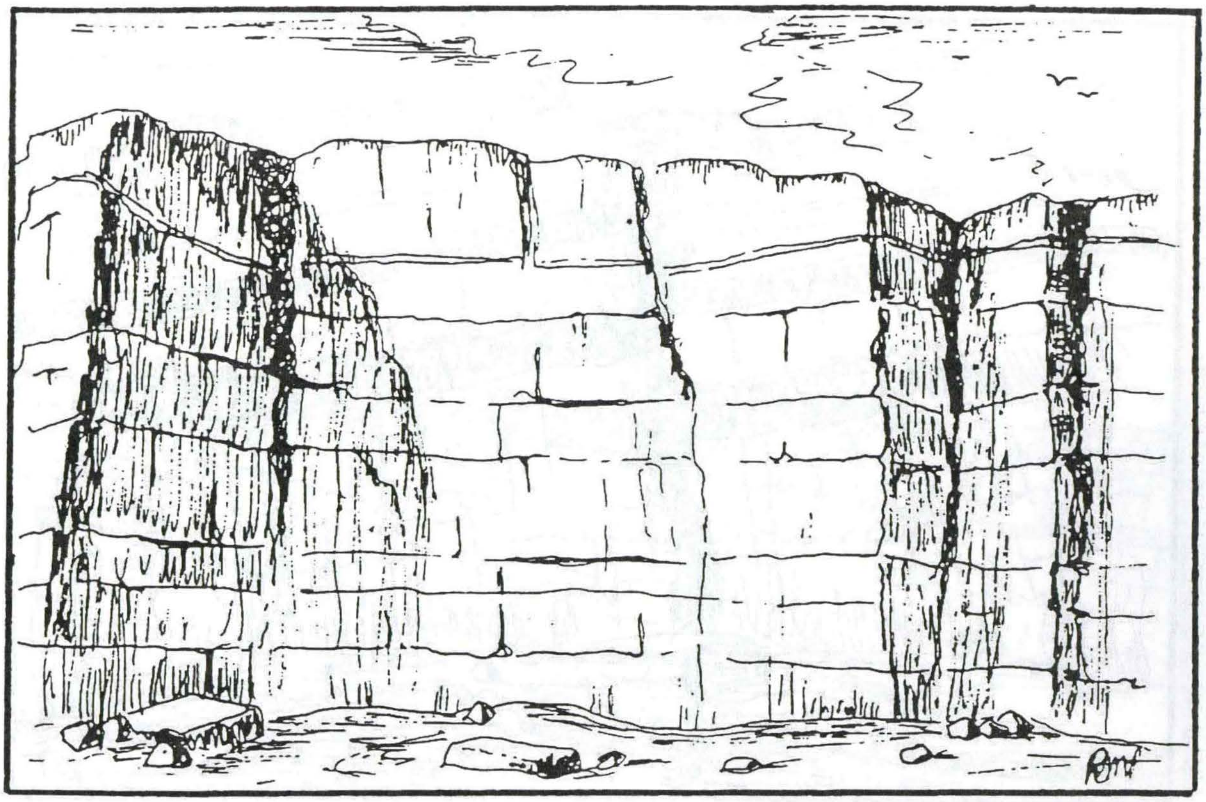


Figure 6.1

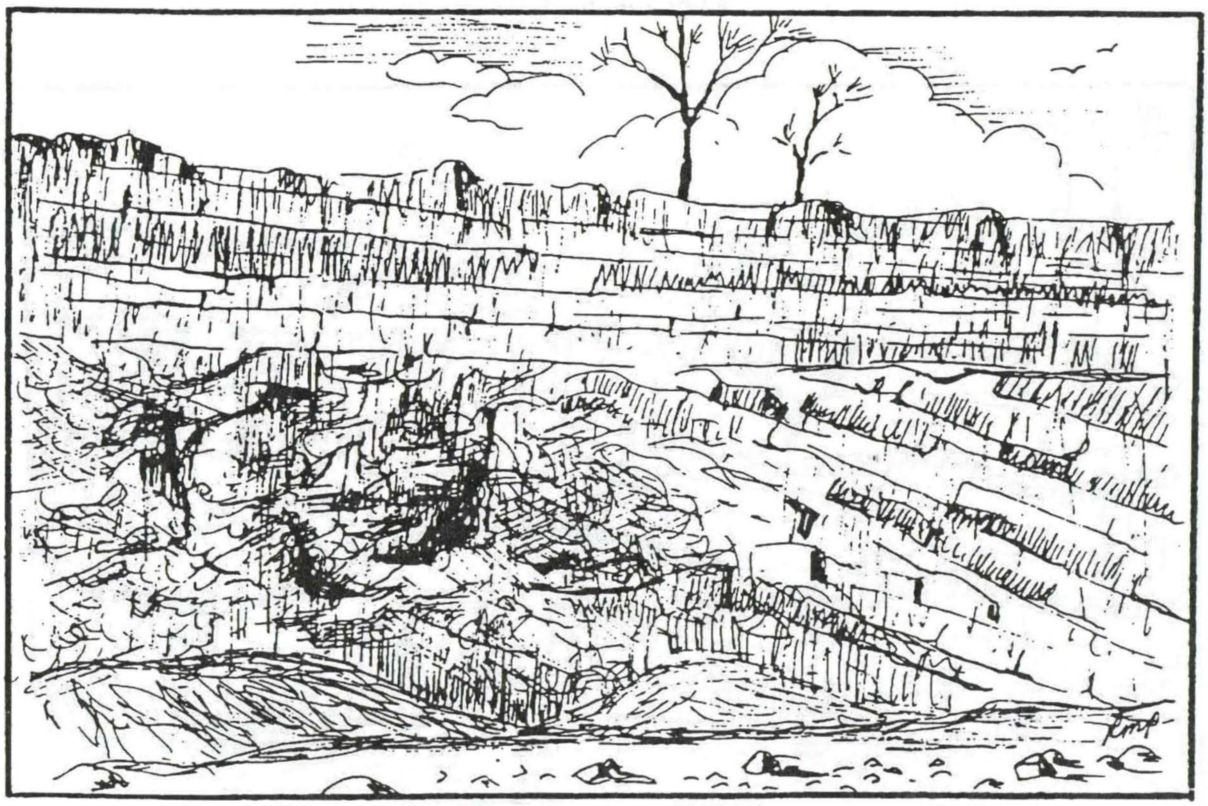


Figure 6.2

Deleterious Materials

Ground water moving along vertical joints and horizontal bedding planes has often left large void spaces in the rock. 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. Some rock became 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 the contained 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.

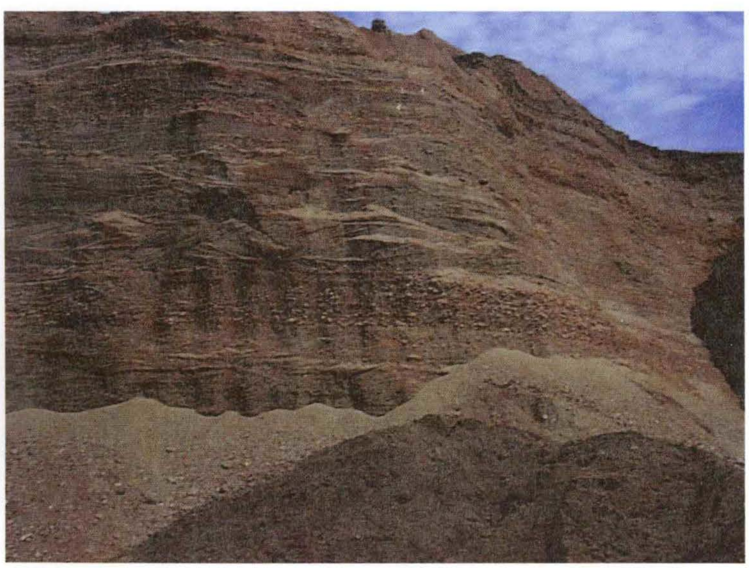
Production Changes

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 partings on the bedding planes, the removing or scalping of the minus 19 mm (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 beneficfation.

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 with areas containing high shale, etc. 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. Most gravel coarse aggregate perform only moderately well in pavement because, despite containing relatively high percentages of extremely durable igneous materials, they also contain significant percentages of good to poor quality limestone, and of course, the cherts, 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.

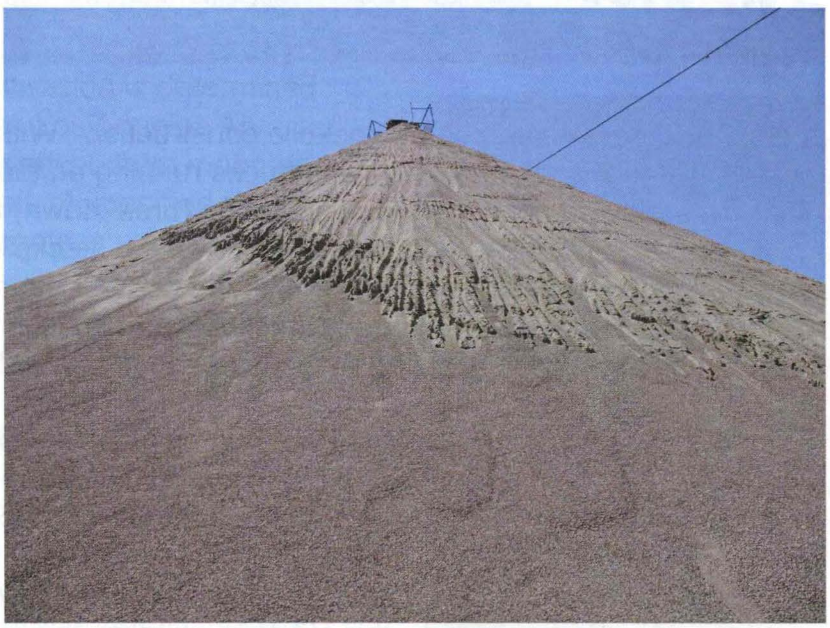
The quality of the limestone fraction, however, can affect the durability of pavement. Consequently, very few gravel coarse aggregates comply with the durability requirements for use in pavements on the primary highway system. When necessary, gravel coarse aggregates can be separated and tested according to rock type using a modification of the ASTM Standard Recommended Practice for Petrographic Examination of Aggregates for Concrete. This can be extremely helpful in identifying the types and amounts of poor quality materials present.

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 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.

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 75μm (#200) sieve for the particle aggregate involved.

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 1.70 mm (#12) sieve is reported as the loss due to abrasion, the percentage of wear.

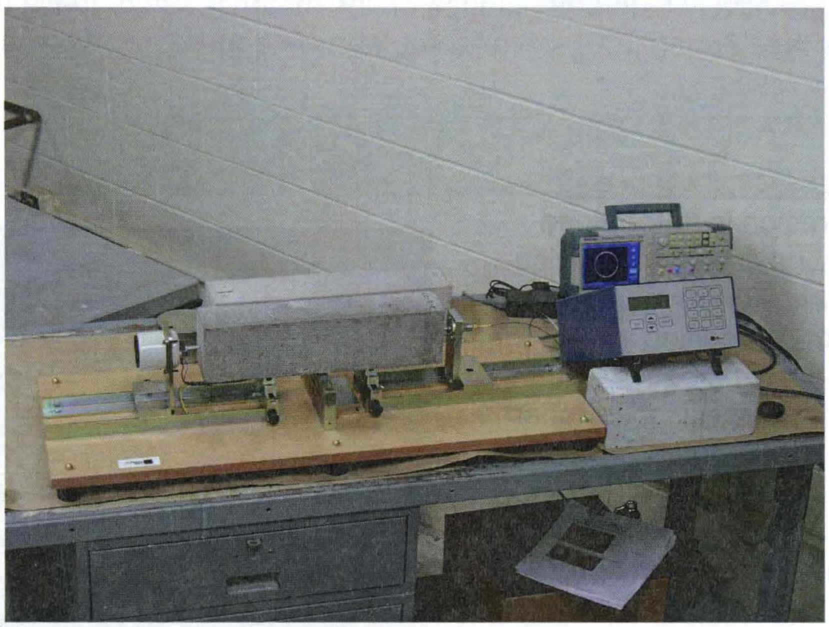
Natural gravels will generally develop wear losses of 20% to 35% when tested for abrasion resistance. Crushed limestone aggregates will generally develop wear losses of 30% to 45%. Losses of 45% or more are commonly accepted to be indicative of aggregates with poor resistance to abrasion.

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 for up to 30 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.

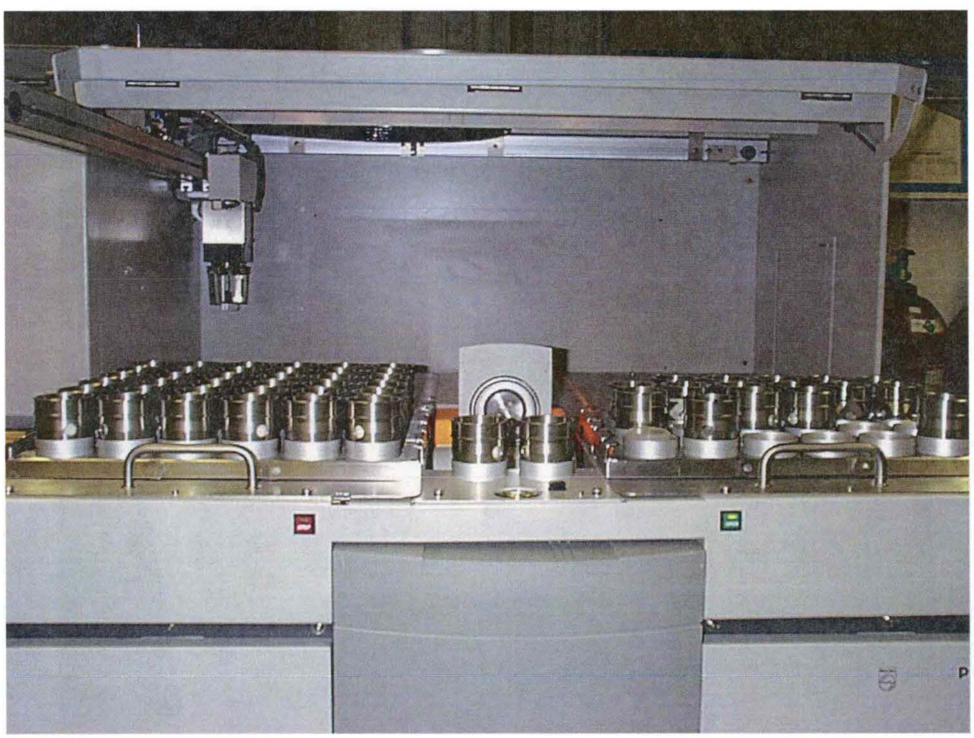
When a pavement performance history is not available, we have relied on ASTM Designation C666, Method B to make laboratory determination of the durability class. This consists of a series of 300 freeze and thaw test cycles on a concrete specimen and takes approximately 6 months to complete.

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.

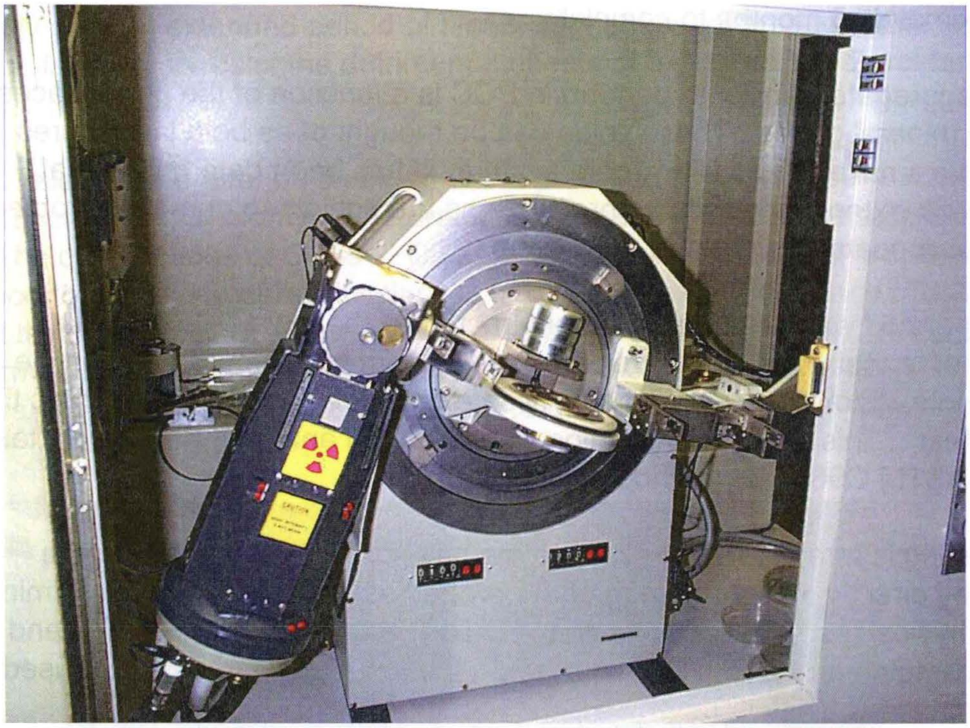
A unique apparatus was designed and constructed by the Iowa DOT Materials Laboratory personnel which measures the pore system of an aggregate particle in a relatively simple, quick and environmentally safe test. the test is referred to as the "Iowa Pore Index Test". This test, in conjunction with chemical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

<u>Soundness</u>

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.

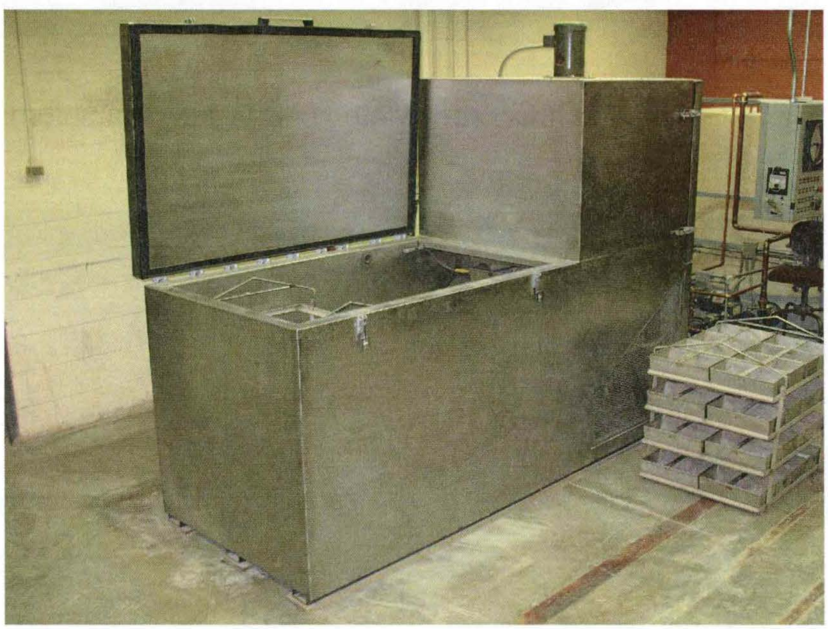
Method of Test for Determining the Soundness of Aggregates by Freezing and Thawing

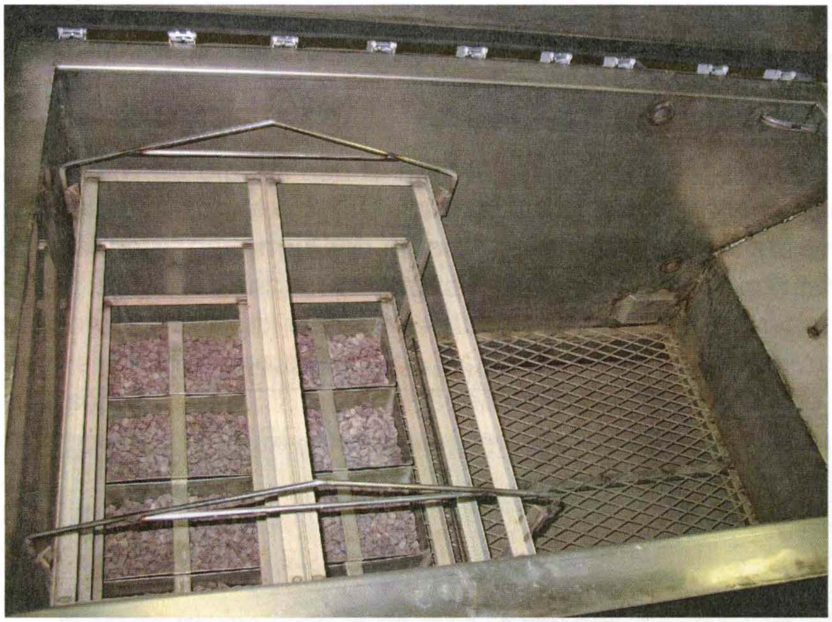
Test samples of coarse aggregate are alternately frozen and thawed for a prescribed number of cycles-16 in Method "A" for higher quality requirements, and 25 cycles in Method "C" for lower quality requirements. In both methods, the percentage passing the 2.36 mm (#8) sieve, computed to a clean dry weight 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. Any reasonably clean, coarse aggregate will perform well in this test and it is used for all materials, which do not require high quality aggregates.

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, included in this manual, and personnel performing this test must possess a Level II Aggregate 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.

Aggregate Moisture

The amount of individual aggregates used in a Portland cement concrete mix is determined in the design process based on the Saturated-Surface-Dry weight of the material. Terms used to describe the moisture content of aggregate are as follows:

• Oven-dry (or constant-dry weight) – containing no surface or internal moisture.

• Air-dry – dry at the particle surface but containing some internal moisture – this is somewhat absorbent.

• Saturated-Surface-Dry – an ideal condition in which the aggregate can neither absorb nor contribute water. In this condition, the interior has absorbed all the moisture it can hold, but the surface is dry.

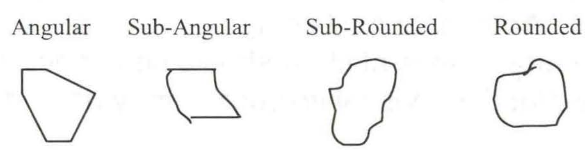
• Damp or Wet – containing moisture on the particle surface.

The free moisture present in aggregates must be accounted for when used in a Portland Cement Concrete mix. Aggregates containing free moisture carry that moisture into the mix during the batching process. If corrections are not made, the weight of the individual aggregates containing this moisture will result in aggregate under yielding, that is, less aggregate in the mix than is required in the mix design. This "extra" water will also affect the water/cement ratio.

An aggregate particle's internal structure is made up of solid matter and voids that may or may not contain water. Sometimes the aggregates to be used may be in an "absorbent" condition, which means that during the batching process, the aggregates will actually absorb some of the mix water, resulting in a mix drier than intended, with more aggregate by weight than designed. Iowa specifies that a stockpile of coarse aggregate having absorption of 0.5% or more shall be wetted and allowed to drain for at least 1 hour before use in the PCC mix. Fine aggregate, which is normally washed during the production phase, must be allowed to drain at least 24 hours before use in the mix. Also, at the time of use, aggregates must be handled in a manner that will prevent variations of more than 0.5 percent in moisture content of successive batches. The plant operator is responsible to devise remedial measures. The moisture content is normally determined in Iowa by the pycnometer method when tested at the time of use (I.M. 308, included in this manual). Personnel performing this test must have a valid Iowa Level II Aggregate certification. If water can be observed draining or dripping from any individual aggregate moisture sample, the moisture content cannot be measured successfully with the pycnometer, nor can it be uniformly controlled in the proportioning process. The moisture content must be allowed to stabilize (drain) before using the affected aggregate.

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. As an aggregate is moved or handled, there is tendency for the particle sizes to separate. This separation is known as segregation. 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.

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 = Mass in grams of aggregate in a saturated-surface-dry condition

P = Mass in grams of the pycnometer filled with water

W= Mass 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) =

Moisture Tests (I.M. 308)

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

$$\text{Percent Moisture} = \frac{(W - W1)(Gs)(100)}{(Gs - 1)(s)}$$

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

W1= Mass in grams of the pycnometer containing the wet sample and sufficient amount of water to fill the remaning volume of the pycnometer.

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

s = Mass in grams of wet sample

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

1. W = 3916.5 W1 = 3907.0 Gs = 2.61 s = 2000.0

2. W = 2096.5 W1 = 2078.5 Gs = 2.66 s = 1000.0

3. W = 3903.5 W1 = 3911.0 Gs = 2.70 s = 2000.0

4. W = 2204.5 W1 = 2184.0 Gs = 2.60 s = 1000.0

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 38.1 mm (1 ½ in.) sieve and is retained on a 25.4 mm (1 in.) sieve would not contain any particle larger than 38.1 mm (1 ½ in.) nor smaller than 25.4 mm (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.

Iowa Department of Transportation Standard Specifications normally set limits on the percent passing a given sieve. The percent of the total weight retained on each sieve must be found first.

Coarse Aggregate Sieves

SI Units	US Units
37.5 mm	1 ½ inch
25.0 mm	1 inch
19.0 mm	¾ inch
12.5 mm	½ inch
9.50 mm	3/8 inch
4.75 mm	No. 4 (0.187 inch)

Fine Aggregate Sieves

SI Units	US Units
4.75 mm	No. 4 (0.187 in.)
2.36 mm	No. 8 (0.0937 in.)
1.18 mm	No. 16 (0.0469 in.)
0.600 mm	No. 30 (0.0234 in.)
0.300 mm	No. 50 (0.0117 in.)
0.150 mm	No. 100(0.0059 in.)

To calculate percent retained on any sieve, merely divide the weight retained by the original dry weight of the sample and multiply by 100. The percent passing each sieve is then determined from the percent-retained column.

Percent retained =
$\dfrac{\text{Weight retained}}{\text{Original Dry Weight}} \times 100$

Aggregate Sieve Analysis

(Coarse or fine using Box and 203 mm (8 in.) Sieves; or 305 mm (12 in.) Sieves)

1. Obtain a field sample (per I.M. 301)

2. Reduce the field sample (per I.M. 336) to the proper test sample size listed in I.M. 301.

3. When required to determine the percent passing the 75 µm (#200) sieve, or when testing a Fine Aggregate sample, dry the test sample to a constant mass (weight). (Note: A second (smaller) sample of coarse aggregate may be obtained (per I.M. 336) from the field sample to test for the percent passing the 75 µm sieve. See I.M. 306 for the appropriate sample size. In this case, the larger sample of coarse aggregate needs only to be in a "surface-dry" condition when sieving down through the 2.36 mm (#8) screen).

4. Cool the sample if dried to a constant mass, weigh and record as the Original Dry Mass.

   4a. When testing for the percent passing the 75 µm sieve, wash the entire sample over a 75 µm wash sieve per I.M. 306.

   4b. Dry the washed sample to a constant mass, cool, weigh, and record as Dry Mass Washed.

   4c. Determine washing loss and record in both places on worksheet.

5. Place the sample in the appropriate sieves and sieve to completion:
   - Coarse Aggregate in box sieves, 37.5 mm through 2.36 mm (1 ½ in. through #8)
   - Fine Aggregate in 203 mm or 305 mm round sieves, 9.5 mm through 75 µm (3/8 in. through #200)
   - Combined or Fine Aggregate in 305 mm sieves, 25 mm through 75 µm (1 in. through #200)

   (Note the largest sieve size needed in any case is dependent on the maximum particle size in the sample).

6. Clean the retained material from each sieve, weigh, and record each increment to the nearest 0.5 gram saving each increment individually until the entire test procedure is completed.

7. Add the mass retained column, including the washing loss and pan if the sample was washed. Check weighing accuracy by dividing the total by the original mass x 100 (and/or the total minus the washing loss divided by the dry mass washed x 100 if the sample was washed).

8. Calculate the percent retained for each sieve by dividing the mass retained on each sieve by the Original Dry Mass x 100. Remember to combine the washing loss and pan for this calculation if sample was washed.

9. Add the percent retained column, prorating as needed, to equal 100 %.

10. Determine the percent passing each sieve by consequently subtracting the percents retained starting with the sieve that had 100 % passing (the smallest sieve used which had no material retained).

Coarse Aggregate Wash Sample

(Percent passing 75 µm sieve only)

1. Dry the sample to a constant mass, cool, weigh, and record as Original Dry Mass (at the bottom of the worksheet).

2. Wash the sample over the 75 mm sieve per I.M. 306.

3. Dry the washed sample to a constant mass, cool, weigh and record as Dry Mass Washed.

4. Determine the Washing Loss and record in appropriate places on worksheet.

5. Screen the sample over a box 2.36 mm sieve, discarding the material retained on the 2.36 mm sieve.

6. Place the minus 2.36 mm material in a nest of round sieves (300 µm, 150 µm, and 75 µm) and pan.

7. Place the nest of sieves in a mechanical shaker (or sieve by hand) until sieving to completion is achieved (usually 5 minutes in a mechanical shaker).

8. Weigh and record only the material retained in the pan.

9. Combine the Washing Loss and Pan masses and divide by the Original Dry Mass x 100.

10. Record as percent passing the 75 µm sieve.

(Now it is safe to discard your sample increments)

Combined Aggregate Sieve Analysis

(With Box and Round 203 mm (8 in.) diameter sieves)

Phase 1

1. Obtain a field sample (per I.M. 301).

2. Reduce the field sample (per I.M. 336) to the proper test sample size listed in I.M. 301.

3. Dry the test sample to a constant mass (weight), allow to cool, weigh to nearest 0.5 gram and record as Original Dry Mass.

4. Wash the sample over the 75 µm wash sieve (per I.M. 306).

5. Dry the washed sample to a constant mass, cool, weigh and record the mass as the Dry Mass of Washed Sample.

6. Determine the Washing Loss and record in both locations on worksheet.

7. Sieve the sample through the required box sieves finishing with the 4.75 mm (#4) or 2.36 mm (#8).

8. Clean the retained material from each sieve; weigh and record each increment (record in the second column of worksheet), saving each increment individually until the entire test procedure is completed.

Note: At this point technician must decide if the amount of material passing the 4.75 µm or 2.36 µm box sieve will create an overload situation on any of the 203 mm sieves (over 200 grams on a sieve).

Phase 2 (Overload not anticipated)

1. Place the minus 4.75 mm (or 2.36 mm) material in the nest of 203 mm round sieves and sieve in the mechanical shaker for a period long enough to obtain sieving to completion (usually 10 minutes).

2. Clean the retained material from each sieve; weigh and record each increment (record in the second column of worksheet), saving each increment individually until the entire test procedure is completed.

3. Add the entire mass retained column including the pan and washing loss

4. Determine the weighing accuracy (± 0.5%)

5. Calculate the percent retained on each sieve (individual mass + dry mass x 100) to nearest 0.1%. (Remember to combine the washing loss and pan for this calculation)

6. Total the percent retained column, prorating as necessary, to equal 100%.

7. Calculate the percent passing each sieve by consecutively subtracting the percent retained, starting with the sieve that had 100% passing (the smallest sieve used which had no material retained).

8. The percent passing the 75 µm (#200) sieve must equal the last result obtained in the percent retained column.

Phase 2 (overload on 203 mm sieves anticipated)

1. Weigh and record the material passing the 4.75 mm box sieve as the total minus 4.75 mm mass (W1).

2. Reduce the material passing the 4.75 mm box sieve using the 25 mm (1 in.) sample splitter (a smaller splitter may be used if available). **The minimum mass of the reduced sample is 500 grams.**

3. Weigh and record the reduced minus 4.75 mm material as the reduced minus 4.75 mm mass (W2).

4. Divide W1 by W2 and record as conversion factor (four places to the right of the decimal point).

5. Place the reduced sample into the nest of 203 mm sieves (starting with the 2.36 mm sieve) and sieve in the mechanical sieve shaker for a period long enough to obtain sieving to completion (usually 10 minutes).

6. Clean the retained material from each sieve; weigh and record each increment (record in first column on worksheet), saving each increment individually until the entire test procedure is completed.

7. Add the column including the pan (excluding the washing loss) and check weighing accuracy by dividing the column total by the W2 weight (±0.5% tolerance).

8. Multiply each mass retained (B) including the pan by the conversion factor and record the result in the second column (A) to the nearest 0.1%.

9. Add the entire second column (including the masses retained on the +4.75 mm sieves and washing loss).

10. Divide this total by the Original Dry Mass of Sample x 100. The result must be within ± 0.5%.

11. Divide each mass retained in this column (second column) by the Original Dry Mass of Sample x 100 and record in the percent retained to the nearest 0.1%.

12. Add the percent retained column, prorating as needed to equal 100%.

13. Determine percent passing each sieve by consecutively subtracting the percents retained starting with the sieve that had 100% passing.

14. The percent passing the 75 µm sieve must equal the last result obtained in the percent retained column.

(Now it is safe to discard your sample increments)

Form 820180ex 11-01

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

Original Dry Mass:	511.3	Total Minus 4.75 mm (W1):	
Dry Mass Washed:	509.0	Reduced Minus 4.75mm(W2)	
Washing Loss:		Conversion Factor: W1/W2	
		Calculated Weight (A)=Conversion Factor x (B)	

Sieve Size	Reduced Minus4.75mm	Total or Calc. Weight Retd.	% Retained	% Passing	Specs.
37.5mm(1½")					
25mm (1")					
19mm (¾)					
12.5mm (½")					
9.5mm (⅜")					
4.75mm (4)		19.1			
2.36mm (8)	(B)	98.3 (A)			
1.18mm (16)	(B)	124.0 (A)			
600µm (30)	(B)	160.9 (A)			
300µm (50)	(B)	77.2 (A)			
150µm (100)	(B)	22.6 (A)			
75µm (200)	(B)	7.3 (A)			
Wash		2.3			
Pan	(B)	0.4 (A)			
Total					
Tolerance					

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

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

Date Reported:	Cert No.:	
Tested By:		

Comments: ______________________________

Form 820180ex 11-01

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

Original Dry Mass:	511.3	Total Minus 4.75 mm (W1):	
Dry Mass Washed:	509.0	Reduced Minus 4.75mm(W2)	
Washing Loss:	2.3	Conversion Factor: W1/W2	
		Calculated Weight (A)=Conversion Factor x (B)	

Sieve Size	Reduced Minus4.75mm	Total or Calc. Weight Retd.	% Retained	% Passing	Specs.
37.5mm(1½")					
25mm (1")					
19mm (¾)					
12.5mm (½")					
9.5mm (⅜")				100.0	100
4.75mm (4)		19.1	3.7	96.3	90-100
2.36mm (8)	(B)	98.3 (A)	19.2	77.1	70-100
1.18mm (16)	(B)	124.0 (A)	24.3	52.8	
600μm (30)	(B)	160.9 (A)	31.5(31.4)	21.4	10-60
300μm (50)	(B)	77.2 (A)	15.1	6.3	
150μm (100)	(B)	22.6 (A)	4.4	1.9	
75μm (200)	(B)	7.3 (A)	1.4	0.5	0-1.5
Wash		2.3	0.5		
Pan	(B)	0.4 (A)			
Total		512.1	100.1(100.0)		
Tolerance		100.2			

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

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

Date Reported:	Cert No.:
Tested By:	

Comments: ______________________________

Form 820180ex 11-01

Lab. No.:	2	
Material:	Fine Aggregate – PCC	Grad. No.: 1
Co. & Proj.#:		
Producer:		
Contractor:		
Sampled By:	Date:	
Sample Loc.:		

Original Dry Mass:	542.0	Total Minus 4.75 mm (W1):	
Dry Mass Washed:	539.6	Reduced Minus 4.75mm(W2)	
Washing Loss:		Conversion Factor: W1/W2	
		Calculated Weight (A)=Conversion Factor x (B)	

Sieve Size	Reduced Minus4.75mm	Total or Calc. Weight Retd.	% Retained	% Passing	Specs.
37.5mm(1½")					
25mm (1")					
19mm (¾)					
12.5mm (½")					
9.5mm (⅜")					
4.75mm (4)					
2.36mm (8)	(B)	101.3 (A)			
1.18mm (16)	(B)	160.7 (A)			
600µm (30)	(B)	179.0 (A)			
300µm (50)	(B)	80.0 (A)			
150µm (100)	(B)	10.9 (A)			
75µm (200)	(B)	5.8 (A)			
Wash		2.4			
Pan	(B)	0.3 (A)			
Total					
Tolerance					

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

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

Date Reported:	Cert No.:
Tested By:	

Comments: ______________________________

Form 820180ex 11-01

Lab. No.:	2	
Material:	Fine Aggregate – PCC	Grad. No.: 1
Co. & Proj.#:		
Producer:		
Contractor:		
Sampled By:	Date:	
Sample Loc.:		

Original Dry Mass:	542.0	Total Minus 4.75 mm (W1):	
Dry Mass Washed:	539.6	Reduced Minus 4.75mm(W2)	
Washing Loss:	2.4	Conversion Factor: W1/W2	
		Calculated Weight (A)=Conversion Factor x (B)	

Sieve Size	Reduced Minus4.75mm	Total or Calc. Weight Retd.	% Retained	% Passing	Specs.
37.5mm(1½")					
25mm (1")					
19mm (¾)					
12.5mm (½")					
9.5mm (⅜")					100
4.75mm (4)				100.0	90-100
2.36mm (8)	(B)	101.3 (A)	18.7(18.8)	81.2	70-100
1.18mm (16)	(B)	160.7 (A)	29.6(29.7)	51.5	
600μm (30)	(B)	179.0 (A)	33.0(33.1)	18.4	10-60
300μm (50)	(B)	80.0 (A)	14.8	3.6	
150μm (100)	(B)	10.9 (A)	2.0	1.6	
75μm (200)	(B)	5.8 (A)	1.1	0.5	0-1.5
Wash		2.4	0.5		
Pan	(B)	0.3 (A)			
Total		540.4	99.7(100.0)		
Tolerance		99.7			

Wash Sample	Original Dry Mass:			
	Dry Mass Washed:			
	Washing Loss:			
Sieve Size	Mass Retd.	% Retd.	% Passing	Specs.
75 μm (200)				
Wash				
Pan				

Date Reported:	Cert No.:
Tested By:	

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	3.2	
#8	18.5	
#16	20.0	
#30	21.8	
#50	25.2	
#100	9.5	

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	**3.2**	**3.2**
#8	**18.5**	**21.7**
#16	**20.0**	**41.7**
#30	**21.8**	**63.5**
#50	**25.2**	**88.7**
#100	**9.5**	**98.2**

Total Cumulative Percent = **317.0**

Fineness Modulus = 317.0 ÷ 100 = 3.17

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 11-01

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

Original Dry Mass:	3759.4	Total Minus 4.75 mm (W1):	
Dry Mass Washed:		Reduced Minus 4.75mm(W2)	
Washing Loss:		Conversion Factor: W1/W2	
		Calculated Weight (A)=Conversion Factor x (B)	

Sieve Size	Reduced Minus4.75mm	Total or Calc. Weight Retd.	% Retained	% Passing	Specs.
37.5mm(1½")					
25mm (1")		23.0			
19mm (¾)		381.2			
12.5mm (½")		1476.8			
9.5mm (⅜")		1243.5			
4.75mm (4)		501.0			
2.36mm (8)	(B)	100.7 (A)			
1.18mm (16)	(B)	(A)			
600µm (30)	(B)	(A)			
300µm (50)	(B)	(A)			
150µm (100)	(B)	(A)			
75µm (200)	(B)	(A)			
Wash					
Pan	(B)	30.8 (A)			
Total					
Tolerance					

Wash Sample	Original Dry Mass:		2603.3	
	Dry Mass Washed:		2590.4	
	Washing Loss:			
Sieve Size	Mass Retd.	% Retd.	% Passing	Specs.
75 µm (200)				
Wash				
Pan	1.1			

Date Reported:	Cert No.:	
Tested By:		

Comments: ______________________________

Form 820180ex 11-01

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

Original Dry Mass:	3759.4	Total Minus 4.75 mm (W1):	
Dry Mass Washed:		Reduced Minus 4.75mm(W2)	
Washing Loss:		Conversion Factor: W1/W2	
		Calculated Weight (A)=Conversion Factor x (B)	

Sieve Size	Reduced Minus4.75mm	Total or Calc. Weight Retd.	% Retained	% Passing	Specs.
37.5mm(1½")				100.0	100
25mm (1")		23.0	0.6	99.4	95-100
19mm (¾)		381.2	10.1	89.3	
12.5mm (½")		1476.8	39.3(39.4)	49.9	25-60
9.5mm (⅜")		1243.5	33.1	16.8	
4.75mm (4)		501.0	13.3	3.5	0-10
2.36mm (8)	(B)	100.7 (A)	2.7	0.8	0-5
1.18mm (16)	(B)	(A)			
600μm (30)	(B)	(A)			
300μm (50)	(B)	(A)			
150μm (100)	(B)	(A)			
75μm (200)	(B)	(A)			
Wash			0.8		
Pan	(B)	30.8 (A)			
Total		3757.0	99.9(100.0)		
Tolerance		99.9			

Wash Sample		
	Original Dry Mass:	2603.3
	Dry Mass Washed:	2590.4
	Washing Loss:	12.9

Sieve Size	Mass Retd.	% Retd.	% Passing	Specs.
75 μm (200)			0.5	0-1.5
Wash	12.9	0.5		
Pan	1.1			

Date Reported:	Cert No.:
Tested By:	

Comments: ______________________________

Form 820180ex 11-01

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

Original Dry Mass:	5348.7	Total Minus 4.75 mm (W1):	
Dry Mass Washed:		Reduced Minus 4.75mm(W2)	
Washing Loss:		Conversion Factor: W1/W2	
		Calculated Weight (A)=Conversion Factor x (B)	

Sieve Size	Reduced Minus4.75mm	Total or Calc. Weight Retd.	% Retained	% Passing	Specs.
37.5mm(1½")					
25mm (1")		169.0			
19mm (¾)		516.7			
12.5mm (½")		1817.0			
9.5mm (⅜")		1798.3			
4.75mm (4)		713.9			
2.36mm (8)	(B)	307.1 (A)			
1.18mm (16)	(B)	(A)			
600µm (30)	(B)	(A)			
300µm (50)	(B)	(A)			
150µm (100)	(B)	(A)			
75µm (200)	(B)	(A)			
Wash					
Pan	(B)	24.6 (A)			
Total					
Tolerance					

Wash Sample		
	Original Dry Mass:	2582.8
	Dry Mass Washed:	2561.9
	Washing Loss:	

Sieve Size	Mass Retd.	% Retd.	% Passing	Specs.
75 µm (200)				
Wash				
Pan	0.9			

Date Reported:	Cert No.:	
Tested By:		

Comments: ______________________________

Form 820180ex 11-01

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

Original Dry Mass:	5348.7	Total Minus 4.75 mm (W1):	
Dry Mass Washed:		Reduced Minus 4.75mm(W2)	
Washing Loss:		Conversion Factor: W1/W2	
		Calculated Weight (A)=Conversion Factor x (B)	

Sieve Size	Reduced Minus4.75mm	Total or Calc. Weight Retd.	% Retained	% Passing	Specs.
37.5mm(1½")				100.0	100
25mm (1")		169.0	3.2	96.8	
19mm (¾)		516.7	9.7	87.1	
12.5mm (½")		1817.0	34.0	53.1	
9.5mm (⅜")		1798.3	33.6	19.5	
4.75mm (4)		713.9	13.3	6.2	0-10
2.36mm (8)	(B)	307.1 (A)	5.7	0.5	0-5
1.18mm (16)	(B)	(A)			
600μm (30)	(B)	(A)			
300μm (50)	(B)	(A)			
150μm (100)	(B)	(A)			
75μm (200)	(B)	(A)			
Wash			0.5		
Pan	(B)	24.6 (A)			
Total		5346.6	100.0		
Tolerance		99.96			

Wash Sample	Original Dry Mass:		2582.8	
	Dry Mass Washed:		2561.9	
	Washing Loss:		20.9	
Sieve Size	Mass Retd.	% Retd.	% Passing	Specs.
75 μm (200)			0.8	0-1.5
Wash	20.9	0.8		
Pan	0.9			

Date Reported:	Cert No.:	
Tested By:		

Comments: ______________________________

Form 820180ex 11-01

Lab. No.:	5	
Material:	1" Combined Aggregate	Grad. No.:
Co. & Proj.#:	(Using Box and 203mm sieves)	
Producer:		
Contractor:		
Sampled By:	Date:	
Sample Loc.:		

Original Dry Mass:	3581.0	Total Minus 4.75 mm (W1):	2262.9
Dry Mass Washed:	3393.7	Reduced Minus 4.75mm(W2)	563.1
Washing Loss:		Conversion Factor: W1/W2	
		Calculated Weight (A)=Conversion Factor x (B)	

Sieve Size	Reduced Minus4.75mm	Total or Calc. Weight Retd.	% Retained	% Passing	Specs.
37.5mm(1½")					
25mm (1")		76.5			
19mm (¾)		178.4			
12.5mm (½")		202.0			
9.5mm (⅜")		296.1			
4.75mm (4)		377.8			
2.36mm (8)	103.1 (B)	(A)			
1.18mm (16)	167.6 (B)	(A)			
600µm (30)	186.3 (B)	(A)			
300µm (50)	62.1 (B)	(A)			
150µm (100)	20.3 (B)	(A)			
75µm (200)	14.8 (B)	(A)			
Wash					
Pan	6.9 (B)	(A)			
Total					
Tolerance					

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

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

Date Reported:	Cert No.:
Tested By:	

Comments: ______________________________

Form 820180ex 11-01

Lab. No.:	5		
Material:	1" Combined Aggregate	Grad. No.:	
Co. & Proj.#:	(Using Box and 203mm sieves)		
Producer:			
Contractor:			
Sampled By:		Date:	
Sample Loc.:			

Original Dry Mass:	3581.0	Total Minus 4.75 mm (W1):	2262.9
Dry Mass Washed:	3393.7	Reduced Minus 4.75mm(W2)	563.1
Washing Loss:	187.3	Conversion Factor: W1/W2	4.0186
		Calculated Weight (A)=Conversion Factor x (B)	

Sieve Size	Reduced Minus4.75mm	Total or Calc. Weight Retd.	% Retained	% Passing	Specs.
37.5mm(1½")				100.0	
25mm (1")		76.5	2.1	97.9	
19mm (¾)		178.4	5.0	92.9	
12.5mm (½")		202.0	5.6	87.3	
9.5mm (⅜")		296.1	8.3	79.0	
4.75mm (4)		377.8	10.6	68.4	
2.36mm (8)	103.1 (B)	414.3 (A)	11.6	56.8	
1.18mm (16)	167.6 (B)	673.5 (A)	18.8	38.0	
600μm (30)	186.3 (B)	748.7 (A)	20.9(21.0)	17.0	
300μm (50)	62.1 (B)	249.6 (A)	7.0	10.0	
150μm (100)	20.3 (B)	81.6 (A)	2.3	7.7	
75μm (200)	14.8 (B)	59.5 (A)	1.7	6.0	
Wash		187.3	6.0		
Pan	6.9 (B)	27.7 (A)			
Total	561.1	3573.0	99.9(100.0)		
Tolerance	99.6	99.8			

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

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

Date Reported:		Cert No.:	
Tested By:			

Comments: ______________________________

Form 820180ex 11-01

Lab. No.:	6	
Material:	3/4" Combined Aggregate	Grad. No.:
Co. & Proj.#:	(Using Box and 203mm sieves)	
Producer:		
Contractor:		
Sampled By:	Date:	
Sample Loc.:		

Original Dry Mass:	2296.0	Total Minus 4.75 mm (W1):	1023.9
Dry Mass Washed:	2201.9	Reduced Minus 4.75mm(W2)	512.0
Washing Loss:		Conversion Factor: W1/W2	
		Calculated Weight (A)=Conversion Factor x (B)	

Sieve Size	Reduced Minus4.75mm	Total or Calc. Weight Retd.	% Retained	% Passing	Specs.
37.5mm(1½")					
25mm (1")					
19mm (¾)		15.0			
12.5mm (½")		196.0			
9.5mm (⅜")		477.3			
4.75mm (4)		489.7			
2.36mm (8)	163.2 (B)	(A)			
1.18mm (16)	101.0 (B)	(A)			
600µm (30)	97.6 (B)	(A)			
300µm (50)	80.0 (B)	(A)			
150µm (100)	41.3 (B)	(A)			
75µm (200)	26.0 (B)	(A)			
Wash					
Pan	2.4 (B)	(A)			
Total					
Tolerance					

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

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

Date Reported:	Cert No.:
Tested By:	

Comments: ______________________________

Form 820180ex 11-01

Lab. No.:	6	
Material:	3/4" Combined Aggregate	Grad. No.:
Co. & Proj.#:	(Using Box and 203mm sieves)	
Producer:		
Contractor:		
Sampled By:	Date:	
Sample Loc.:		

Original Dry Mass:	2296.0	Total Minus 4.75 mm (W1):	1023.9
Dry Mass Washed:	2201.9	Reduced Minus 4.75mm(W2)	512.0
Washing Loss:	94.1	Conversion Factor: W1/W2	1.9998
		Calculated Weight (A)=Conversion Factor x (B)	

Sieve Size	Reduced Minus4.75mm	Total or Calc. Weight Retd.	% Retained	% Passing	Specs.
37.5mm(1½")					
25mm (1")				100.0	
19mm (¾)		15.0	0.7	99.3	
12.5mm (½")		196.0	8.5	90.8	
9.5mm (⅜")		477.3	20.8	70.0	
4.75mm (4)		489.7	21.3	48.7	
2.36mm (8)	163.2 (B)	326.4 (A)	14.2	34.5	
1.18mm (16)	101.0 (B)	202.0 (A)	8.8	25.7	
600μm (30)	97.6 (B)	195.2 (A)	8.5	17.2	
300μm (50)	80.0 (B)	160.0 (A)	7.0	10.2	
150μm (100)	41.3 (B)	82.6 (A)	3.6	6.6	
75μm (200)	26.0 (B)	52.0 (A)	2.3	4.3	
Wash		94.1	4.3		
Pan	2.4 (B)	4.8 (A)			
Total	511.5	2295.1	100.0		
Tolerance	99.9	100.0			

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

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

Date Reported:	Cert No.:	
Tested By:		

Comments: ______________________

Form 820180ex 11-01

Lab. No.:	7	
Material:	¾" Combined Aggregate	Grad. No.:
Co. & Proj.#:	(Using 305mm sieves)	
Producer:		
Contractor:		
Sampled By:	Date:	
Sample Loc.:		

Original Dry Mass:	2247.5	Total Minus 4.75 mm (W1):	
Dry Mass Washed:	2091.9	Reduced Minus 4.75mm(W2)	
Washing Loss:		Conversion Factor: W1/W2	
		Calculated Weight (A)=Conversion Factor x (B)	

Sieve Size	Reduced Minus4.75mm	Total or Calc. Weight Retd.	% Retained	% Passing	Specs.
37.5mm(1½")					
25mm (1")					
19mm (¾)		27.0			
12.5mm (½")		243.3			
9.5mm (⅜")		301.1			
4.75mm (4)		511.8			
2.36mm (8)	(B)	432.0 (A)			
1.18mm (16)	(B)	211.6 (A)			
600μm (30)	(B)	116.9 (A)			
300μm (50)	(B)	100.4 (A)			
150μm (100)	(B)	83.0 (A)			
75μm (200)	(B)	54.0 (A)			
Wash					
Pan	(B)	8.3 (A)			
Total					
Tolerance					

Wash Sample				
	Original Dry Mass:			
	Dry Mass Washed:			
	Washing Loss:			
Sieve Size	Mass Retd.	% Retd.	% Passing	Specs.
75 μm (200)				
Wash				
Pan				

Date Reported:	Cert No.:	
Tested By:		

Comments: ______________________________

Form 820180ex 11-01

Lab. No.:	7		
Material:	¾" Combined Aggregate	Grad. No.:	
Co. & Proj.#:	(Using 305mm sieves)		
Producer:			
Contractor:			
Sampled By:		Date:	
Sample Loc.:			

Original Dry Mass:	2247.5	Total Minus 4.75 mm (W1):	
Dry Mass Washed:	2091.9	Reduced Minus 4.75mm(W2)	
Washing Loss:	155.6	Conversion Factor: W1/W2	
		Calculated Weight (A)=Conversion Factor x (B)	

Sieve Size	Reduced Minus4.75mm	Total or Calc. Weight Retd.	% Retained	% Passing	Specs.
37.5mm(1½")					
25mm (1")				100.0	
19mm (¾)		27.0	1.2	98.8	
12.5mm (½")		243.3	10.8	88.0	
9.5mm (⅜")		301.1	13.4	74.6	
4.75mm (4)		511.8	22.8(22.9)	51.7	
2.36mm (8)	(B)	432.0 (A)	19.2	32.5	
1.18mm (16)	(B)	211.6 (A)	9.4	23.1	
600μm (30)	(B)	116.9 (A)	5.2	17.9	
300μm (50)	(B)	100.4 (A)	4.5	13.4	
150μm (100)	(B)	83.0 (A)	3.7	9.7	
75μm (200)	(B)	54.0 (A)	2.4	7.3	
Wash		155.6	7.3		
Pan	(B)	8.3 (A)			
Total		2245.0	99.9(100.0)		
Tolerance		99.9			

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

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

Date Reported:		Cert No.:	
Tested By:			

Comments: ______________________________

Form 820180ex 11-01

Lab. No.:	8		
Material:	½ " Combined Aggregate	Grad. No.:	
Co. & Proj.#:	(Using 305mm sieves)		
Producer:			
Contractor:			
Sampled By:		Date:	
Sample Loc.:			

Original Dry Mass:	1631.0	Total Minus 4.75 mm (W1):	
Dry Mass Washed:	1526.5	Reduced Minus 4.75mm(W2)	
Washing Loss:		Conversion Factor: W1/W2	
		Calculated Weight (A)=Conversion Factor x (B)	

Sieve Size	Reduced Minus4.75mm	Total or Calc. Weight Retd.	% Retained	% Passing	Specs.
37.5mm(1½")					
25mm (1")					
19mm (¾)					
12.5mm (½")		13.1			
9.5mm (⅜")		295.4			
4.75mm (4)		383.7			
2.36mm (8)	(B)	396.0 (A)			
1.18mm (16)	(B)	167.7 (A)			
600µm (30)	(B)	86.6 (A)			
300µm (50)	(B)	77.0 (A)			
150µm (100)	(B)	62.3 (A)			
75µm (200)	(B)	39.1 (A)			
Wash					
Pan	(B)	6.6 (A)			
Total					
Tolerance					

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

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

Date Reported:	Cert No.:	
Tested By:		

Comments: ______________________________

Form 820180ex 11-01

Lab. No.:	8	
Material:	½ " Combined Aggregate	Grad. No.:
Co. & Proj.#:	(Using 305mm sieves)	
Producer:		
Contractor:		
Sampled By:	Date:	
Sample Loc.:		

Original Dry Mass:	1631.0	Total Minus 4.75 mm (W1):	
Dry Mass Washed:	1526.5	Reduced Minus 4.75mm(W2)	
Washing Loss:	104.5	Conversion Factor: W1/W2	
		Calculated Weight (A)=Conversion Factor x (B)	

Sieve Size	Reduced Minus4.75mm	Total or Calc. Weight Retd.	% Retained	% Passing	Specs.
37.5mm(1½")					
25mm (1")					
19mm (¾)				100.0	
12.5mm (½")		13.1	0.8	99.2	
9.5mm (⅜")		295.4	18.1	81.1	
4.75mm (4)		383.7	23.5	57.6	
2.36mm (8)	(B)	396.0 (A)	24.3	33.3	
1.18mm (16)	(B)	167.7 (A)	10.3	23.0	
600μm (30)	(B)	86.6 (A)	5.3	17.7	
300μm (50)	(B)	77.0 (A)	4.7	13.0	
150μm (100)	(B)	62.3 (A)	3.8	9.2	
75μm (200)	(B)	39.1 (A)	2.4	6.8	
Wash		104.5	6.8		
Pan	(B)	6.6 (A)			
Total		1632.0	100.0		
Tolerance		100.1			

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

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

Date Reported:	Cert No.:
Tested By:	

Comments: ____________________________________

Form 821278
12/92

IOWA DEPARTMENT OF TRANSPORTATION

CERTIFIED GRADATION TEST REPORT

☐ Certified Sample

☒ Monitor Sample

☐ Verification Sample

County: Delaware
Project: WHS
Contractor:
Contract #:
Design:
Date: Oct 27, 2000 Report No.: 3

Source Name Tegler Pit T-203A No. A28504 Source Location NE Sec 36 Twp 89 Range w2 County Delaware

Material Concrete Sand Class Gradation No 1 Beds

Material Producer BARD Concrete Company Destination Stockpile Sampled At Pit 10-5, 13, 19

Date Sampled	Sample Identification	Sampled By	Tested By	Sieve Analysis Percent Passing 37.5mm (1 1/2in)	26.5mm (1.00in)	19mm (3/4in)	13.2mm (0.50in)	9.5mm (3/8in)	4.75mm (No.4)	2.36mm (No.8)	1.18mm (No.16)	600µm (No.30)	300µm (No.50)	150µm (No100)	75µm (No200)	Other Test Results			Comp	Tons
* Production Limits			Max.					100	100	100		54			1.5					
			Min.						90	70					0					
Oct. 5	DL-192-00	DOT	Like					100	97	85	68	44	15	1.7	0.4					
Oct. 5	T18-00	Producer	S.L.					100	94	83	64	42	15	1.3	0.2					
Oct. 13	DL-197-00	DOT	Like					100	97	86	68	45	16	1.9	0.4					
Oct. 13	T21-00	Producer	L.M.					100	96	84	67	44	15	1.2	0.2					
Oct. 19	DL-202-00	DOT	Like					100	97	90	76	49	15	1.5	0.4					
Oct. 20	T23-00	Producer	S.L.					100	96	86	70	46	16	1.5	0.4					

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 Bard Concrete Company
Roger Boulet

File

District 6 personnel have made a comparison of gradations. No significant difference exists between these results.

ESTIMATED QUANTITY 0 TONS

TOTAL PREVIOUSLY CERTIFIED 30,000 TONS

TOTAL CERTIFIED TO DATE 42,000 TONS

CERTIFICATION NUMBER EC222

*AGREED by the Contractor/producer

Reported By Don Like

Representing Iowa DOT

Distribution: Materials Engr.; Project Engr.; Certified Technician; Area Inspector

Form 821278
12/92

IOWA DEPARTMENT OF TRANSPORTATION

CERTIFIED GRADATION TEST REPORT

[X] Certified Sample

[ ] Monitor Sample

[ ] Verification Sample

County: Jasper
Project: IM-80-5(184)160--13-5
Contractor: Manatt's
Contract #:
Design:
Date: 7/24/00 Report No.: 36

Source Name #552 Colfax T-203A No. A50502 Source Location NE Sec 01 Twp 79 Range 21W County 50

Material Concrete Sant Class Gradation No 1 Beds

Material Producer Van Dusseldorp S&G Destination Sampled At Colfax Plant

Date Sampled	Sample Identification	Sampled By	Tested By	Sieve Analysis Percent Passing 37.5mm (1 1/2in)	26.5mm (1.00in)	19mm (3/4in)	13.2mm (0.50in)	9.5mm (3/8in)	4.75mm (No.4)	2.36mm (No.8)	1.18mm (No.16)	600µm (No.30)	300µm (No.50)	150µm (No100)	75µm (No200)	Other Test Results			Comp	Tons
* Production Limits			Max.						100	100		50			1					
			Min.					100	90	70		10		0						
7/17/00	CCC00-0258	CC	CC	Local Area				100	99	91	75	46	12	1.7	0.4					1500
7/18/00	CCC00-0267	CC	CC	" "	" "			100	99	91	75	46	12	1.2	0.3					1500

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 Copies: Materials Engr.
Van Dusseldorp

File Des Moines Lab
CC

ESTIMATED QUANTITY 3000 0 TONS

TOTAL PREVIOUSLY CERTIFIED 33,750 0 TONS

TOTAL CERTIFIED TO DATE 36,750 0 TONS

CERTIFICATION NUMBER CI 906

*AGREED by the Contractor/producer

Reported By Charlotte Cunningham

Distribution: Materials Engr.; Project Engr.; Certified Technician; Area Inspector

Representing Van Dusseldorp Sand & Gravel

800240E - 04/00 computer

PCC Plant Report

Date of Placement		Location From	Location To
Mix 1	10/19/01	124+00	178+50
Mix 2			
Mix 3			
Mix 4			
Mix 5			

Project No.: FM91(15)-56-91
Plant Name: Jensen - R63 & Hwy 92
Contractor: Irving F. Jensen
Weather: Sunny - Cool

Contract ID: 73912
County: Warrem
Temp. (°F) Min: 40
Temp. (°F) Max: 65

Report No.: 9
Date This Report: 10/19/01
Date Of Last Report: 10/18/01
Structures Des. No:

Check Mix(x)		Check One(x)		SEND
Central	X	Paving	X	(Daily)
Ready		Structure		(Weekly)
		Incidental		(Weekly)
		Patching		(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	Grade	Avg w/c Ratio	Max w/c Ratio
1	C-3WR	1,011.50	105.2	3.3	2.65	1,380				0.5	2.68	1,702	571			1,427		1,711	56	175.0		0.405	0.489
2	C-3WR	425.00	106.9	3.0	2.65	1,380				0.3	2.68	1,702	571			1,423		1,707	48	173.0		0.387	0.489
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

123

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

Batched Check One (X)	Today	Week	Total To Date
Concrete (CY):	1,436.50		
Cement (tons):	410.12		

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:	AEA-15/SIKA	4.5 oz./yd.	J60038M
Water Reducer:	Plastocrete 161/SIKA	3 oz./100#	J60011P
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

	Type	Sp. Gr.	Source
Cement:	1	3.14	Ash Grove
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:		A25512	3
Intermediate:			
Fine:		A77524	1

Remarks

C.P.I.: John Doe SE000

Monitor: Mike Brown SE999

23-10 Distribution: ____ Central Materials ____ DME ____ Proj. Eng. ____ Plant

Form 821278
12/92

IOWA DEPARTMENT OF TRANSPORTATION

CERTIFIED GRADATION TEST REPORT

County: Jasper
Project: IM-80-5(184)160--13-5
Contractor: Manatt's
Contract #:
Design:
Date: 7/24/00 Report No.: 36

[X] Certified Sample

[ ] Monitor Sample

[ ] Verification Sample

Source Name #552 Colfax T-203A No. A50502 Source Location NE Sec 01 Twp 79 Range 21W County 50

Material Concrete Sant Class Gradation No 1 Beds

Material Producer Van Dusseldorp S&G Destination Sampled At Colfax Plant

Date Sampled	Sample Identification	Sampled By	Tested By		37.5mm (1 1/2in)	26.5mm (1.00in)	19mm (3/4in)	13.2mm (0.50in)	9.5mm (3/8in)	4.75mm (No.4)	2.36mm (No.8)	1.18mm (No.16)	600µm (No.30)	300µm (No.50)	150µm (No100)	75µm (No200)	Other Test Results				Comp	Tons
	* Production Limits			Max.						100	100		50			1						
				Min.					100	90	70		10		0							
7/17/00	CCC00-0258	CC	CC		Local Area				100	99	91	75	46	12	1.7	0.4						1500
7/18/00	CCC00-0267	CC	CC		" "	" "			100	99	91	75	46	12	1.2	0.3						1500

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 Copies: Materials Engr.
Van Dusseldorp
File Des Moines Lab
CC

ESTIMATED QUANTITY 3000 0 TONS
TOTAL PREVIOUSLY CERTIFIED 33,750 0 TONS
TOTAL CERTIFIED TO DATE 36,750 0 TONS
CERTIFICATION NUMBER CI 906

*AGREED by the Contractor/producer

Reported By Charlotte Cunningham

Distribution: Materials Engr.; Project Engr.; Certified Technician; Area Inspector

Representing Van Dusseldorp Sand & Gravel

122

800241 - 1/07 ver. 3.4

DAILY HMA PLANT REPORT

Project No.:	NHS-6-3(41)--12-77	Contractor:	Quality Asphhalt, Inc.	Class:		Report No.: 1
Contract ID:	77-0006-41	County:	Polk	Size:	3/4"	Design Blows:
Mix Design No.:	ABD5-1005	Recycle Source:		Mix Type:	HMA 3M ESAL	Design Gyrations: 86

Hot Box I.D. No.:		SU6-18A	SU6-18B	SU6-18C	SU6-18D	
Date Sampled:		06/18/05	06/18/05	06/18/05	06/18/05	
Gradation ID:	Specs	GRAD-1A				
1 in. (25mm) Sieve	100	100				
3/4 in. (19mm) Sieve	93-100	99				
1/2 in. (12.5mm) Sieve	83-97	89				
3/8 in. (9.5mm) Sieve	76-90	76				
* #4 (4.75mm) Sieve	43-57	47				
* Moving Average						
* #8 (2.36mm) Sieve	23-33	29				
* Moving Average						
#16 (1.18mm) Sieve		19				
* #30 (600um) Sieve	7-15	13				
* Moving Average						
#50 (300um) Sieve		7.6				
#100 (150um) Sieve		5.4				
* #200 (75um) Sieve	1.3-5.3	4.2				
* Moving Average						
Compliance (Y/N)		Y				
Intended Added, % Binder	5.40		% Binder from RAP			
Actual Added, % Binder		5.28				
Intended Total, % Binder	5.40		Actual % RAP			
Actual Total, % Binder		5.28				
Gmb:		2.373	2.365	2.375	2.371	
Gmm:		2.469	2.477	2.480	2.478	
Pa:		3.9	4.5	4.2	4.3	
Moving Average	3.5-5.0				**4.2**	
Time		7:05 AM	8:35 AM	1:30 PM	4:55 PM	This
Station		112+55	134+22	189+98	244+55	Column
Side		WB	WB	WB	WB	Is For
Sample Tons		373.00	563.00	2,127.00	3,656.00	Dist. Lab
Sublot Tons		500.00	1,100.00	1,100.00	1,494.49	Test
Tons to Date					4,194.49	Results
Fines / Bitumen Ratio	0.6-1.4	1.04				

Time	7:00	9:00	11:00	1:00	3:00	5:00	7:00
Air Temp. °F	65	70	72	74	74	72	70
Binder Temp. °F	300	305	305	300	305	305	305
Mix Temp. °F	295	300	310	300	295	295	300
Mat Temp. °F	275	285	290	280	285	275	280

Placement And Density Record

From Station	To Station	Lane
100+00	155+25	WB
156+95	267+45	WB

Date Placed: 06/18/05
Date Tested: 06/19/05
Course Placed: Surface
Intended Lift Thickness: 2 IN.
Tested By: Bob Anderson

Core No.:	1	2	3	4	5	6	7
Station	110+66	144+35	166+81	198+45	212+16	238+77	254+75
CL Reference	1.0 RT	6.0 LT	2.8 LT	1.9 RT	2.8 LT	8.0 RT	2.8 RT
W 1 Dry	1,205.5	1,236.6	1,388.5	1,279.4	1,145.5	1,401.0	1,215.8
W 2 in H20	685.9	701.6	799.6	736.1	648.2	795.5	696.1
W 3 Wet	1,206.6	1,238.1	1,389.6	1,280.9	1,147.0	1,402.5	1,217.1
Difference	520.7	536.5	590.0	544.8	498.8	607.0	521.0
Field Density	2.315	2.305	2.353	2.348	2.297	2.308	2.334
% Density	97.638	97.216	99.241	99.030	96.879	97.343	98.439
% Voids	6.5	6.9	5.0	5.2	7.2	6.8	5.7
Thickness (in.)	1 5/8	1 3/4	2	1 3/4	1 1/2	2	1 3/4

Gmb (Lot Avg.):	**2.371**	Avg. Field Density:	**2.323**
Gmm (Lot Avg.):	**2.476**	Avg. % Density:	**97.969**
Pa (Lot Avg.):	**4.2**	Avg. % Field Voids:	**6.2**
Target % RAP:		Specified % Density:	95

Q.I. = 2.323 -- (0.95 x 2.371) = **3.21**
0.022

Low Outlier: High Outlier: New Q.I. =

Film Thickness (FT): **10.0** VMA: **13.6** D.O.T. Results Used:

Gsb: 2.598 Gb: 1.0240 Effective % Binder (Pbe): 4.02

Mix Change Information:

Remarks:
VMA within plus or minus one from JMF target value of 13.7
Voids, film thickness and QI comply

Certified Tech: Ray Johnson C1213 Cert. No.
Certified Tech: John Rayson C1312 Cert. No.

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

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 11-01

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

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

Sieve Size	Reduced Minus4.75mm	Total or Calc. Weight Retd.	% Retained	% Passing	Specs.
37.5mm(1½")					
25mm (1")					
19mm (¾)					
12.5mm (½")					
9.5mm (⅜")					
4.75mm (4)					
2.36mm (8)	(B)	(A)			
1.18mm (16)	(B)	(A)			
600µm (30)	(B)	(A)			
300µm (50)	(B)	(A)			
150µm (100)	(B)	(A)			
75µm (200)	(B)	(A)			
Wash					
Pan	(B)	(A)			
Total					
Tolerance					

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

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

Date Reported:	Cert No.:	
Tested By:		

Comments: ______________________________

Form 820180ex 11-01

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

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

Sieve Size	Reduced Minus4.75mm	Total or Calc. Weight Retd.	% Retained	% Passing	Specs.
37.5mm(1½")					
25mm (1")					
19mm (¾)					
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9.5mm (⅜")					
4.75mm (4)					
2.36mm (8)	(B)	(A)			
1.18mm (16)	(B)	(A)			
600µm (30)	(B)	(A)			
300µm (50)	(B)	(A)			
150µm (100)	(B)	(A)			
75µm (200)	(B)	(A)			
Wash					
Pan	(B)	(A)			
Total					
Tolerance					

Wash Sample				
	Original Dry Mass:			
	Dry Mass Washed:			
	Washing Loss:			
Sieve Size	Mass Retd.	% Retd.	% Passing	Specs.
75 µm (200)				
Wash				
Pan				

Date Reported:		Cert No.:
Tested By:		

Comments: ______________________________

Form 820180ex 11-01

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

Original Dry Mass:		Total Minus 4.75 mm (W1):	
Dry Mass Washed:		Reduced Minus 4.75mm(W2)	
Washing Loss:		Conversion Factor: W1/W2	
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600µm (30)	(B)	(A)			
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150µm (100)	(B)	(A)			
75µm (200)	(B)	(A)			
Wash					
Pan	(B)	(A)			
Total					
Tolerance					

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

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

Date Reported:	Cert No.:	
Tested By:		

Comments: ____________________

Form 820180ex 11-01

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

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

Sieve Size	Reduced Minus4.75mm	Total or Calc. Weight Retd.	% Retained	% Passing	Specs.
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9.5mm (⅜")					
4.75mm (4)					
2.36mm (8)	(B)	(A)			
1.18mm (16)	(B)	(A)			
600μm (30)	(B)	(A)			
300μm (50)	(B)	(A)			
150μm (100)	(B)	(A)			
75μm (200)	(B)	(A)			
Wash					
Pan	(B)	(A)			
Total					
Tolerance					

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

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

Date Reported:	Cert No.:	
Tested By:		

Comments: ______________________________

Form 820180ex 11-01

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

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

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150µm (100)	(B)	(A)			
75µm (200)	(B)	(A)			
Wash					
Pan	(B)	(A)			
Total					
Tolerance					

Wash Sample				
	Original Dry Mass:			
	Dry Mass Washed:			
	Washing Loss:			
Sieve Size	Mass Retd.	% Retd.	% Passing	Specs.
75 µm (200)				
Wash				
Pan				

Date Reported:	Cert No.:
Tested By:	

Comments: ______________________________

Form 820180ex 11-01

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

Original Dry Mass:		Total Minus 4.75 mm (W1):	
Dry Mass Washed:		Reduced Minus 4.75mm(W2)	
Washing Loss:		Conversion Factor: W1/W2	
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Sieve Size	Reduced Minus4.75mm	Total or Calc. Weight Retd.	% Retained	% Passing	Specs.
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150μm (100)	(B)	(A)			
75μm (200)	(B)	(A)			
Wash					
Pan	(B)	(A)			
Total					
Tolerance					

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

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

Date Reported:		Cert No.:	
Tested By:			

Comments: ______________________________

Form 820180ex 11-01

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

Original Dry Mass:		Total Minus 4.75 mm (W1):	
Dry Mass Washed:		Reduced Minus 4.75mm(W2)	
Washing Loss:		Conversion Factor: W1/W2	
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150μm (100)	(B)	(A)			
75μm (200)	(B)	(A)			
Wash					
Pan	(B)	(A)			
Total					
Tolerance					

Wash Sample				
	Original Dry Mass:			
	Dry Mass Washed:			
	Washing Loss:			
Sieve Size	Mass Retd.	% Retd.	% Passing	Specs.
75 μm (200)				
Wash				
Pan				

Date Reported:		Cert No.:
Tested By:		

Comments: ______________________________

Form 820180ex 11-01

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

Original Dry Mass:		Total Minus 4.75 mm (W1):	
Dry Mass Washed:		Reduced Minus 4.75mm(W2)	
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150μm (100)	(B)	(A)			
75μm (200)	(B)	(A)			
Wash					
Pan	(B)	(A)			
Total					
Tolerance					

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

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

Date Reported:	Cert No.:	
Tested By:		

Comments: ____

Iowa Department of Transportation

Technical Training and Certification Program

COURSE EVALUATION SHEET

In an effort to improve the Iowa DOT Technical Training and Certification Program, we ask that you fill out this evaluation form after you have taken the exam. Thank you for your cooperation.

Course: ______________________ Location: ______________________

Instructor: ____________________

1. What type of agency are you employed by?

   ____

2. Please rate the following portion of the course on a scale of 1-5. 1 = Poor, 5 = Excellent

   Facility: ________________

   Material: _______________

   Instructors: _____________

   Course Activities: _________
   (lectures, videos, demonstrations, etc.)

3. Are there any changes you would like to see made in the course?

   ____

   ____

REMARKS: