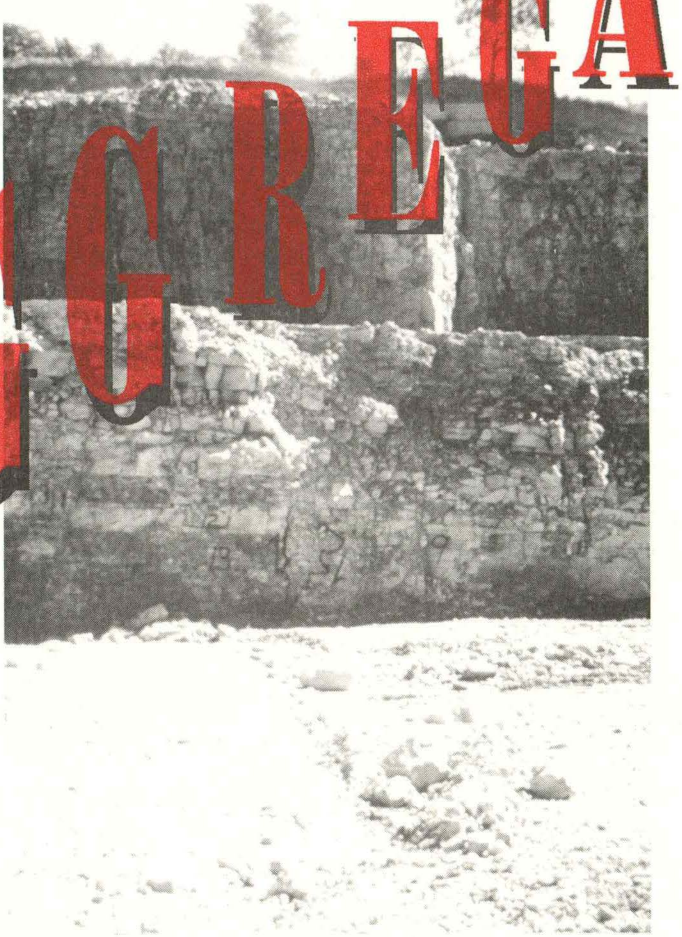
TTCP

Technical Training and Certification Program

AGGREGATE

LEVEL I & LEVEL II



INSTRUCTION TEXT

1996-1997

Iowa Department
of Transportation

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AGGREGATE TECHNICIAN CERTIFICATION PROGRAM

GENERAL

The purpose of the Aggregate Technician Certification Program (ATCP) is to ensure quality sampling and testing of aggregate for gradation by certification of industry and contracting authority personnel.

Through a cooperative program of training, study and examination, technicians will be able to better ensure satisfactory gradation control, identification of aggregates, and documentation.

Sampling shall be done by either a Level I or Level II Certified Aggregate Technician. Testing of aggregate for gradation, in accordance with 1106.01 of the Standard Specifications, shall be by a Level II Certified Aggregate Technician. The technician cannot delegate the sampling or testing responsibility to a non-certified person.

ADMINISTRATION

The ATCP will be carried out in accordance with general policy guidelines established or approved by the Director of the Division of Project Development. The Director will be advised by a Board of Certification composed of the following members:

Engineer - Office of Materials
Engineer - Office of Construction
Representative of the Transportation Center Materials Engineers**
Representative of the Association of General Contractors (AGC of Iowa)
Representative of the Iowa Limestone Producers Association (ILPA)
Representative of the County Engineers

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

Appeals on actions taken in this program shall be submitted to the Program Director. Unresolved appeals will be submitted to the Certification Board.

** Appointed by the Program Director.

REQUIREMENTS

Certification as a Level I or Level II Aggregate Technician can be obtained by successfully passing written and demonstration examinations conducted in accordance with this memorandum.

Certified Technicians may represent any company or agency for which they have been formally authorized as representatives.

Registered Professional Engineers and engineering and geology graduates from accredited institutions will be exempt from taking examinations. In order to obtain certification, these persons must meet all of the following conditions:

A. Be a registered Engineer in the State of Iowa or submit satisfactory evidence of a degree in engineering or geology.

B. Shall have had work assignments in the area of highway construction, aggregate production, distribution and/or use. Shall be intimately connected with the scope of activity defined in the areas of certification.

In requesting certification, a statement of the above information must be submitted to the Iowa DOT Materials Office in Ames. Certificates issued in accordance with these requirements will be subject to the same regulations concerning expiration, etc. that apply to certificates obtained by examinations.

OUT-OF-STATE APPLICANTS

Requests for certification from persons for Level I or Level II Aggregate Technicians from another state will be issued when the following criteria is met:

1. The person must be a certified Aggregate Technician in another state or shall have received equivalent training if the state does not have a certification program.

2. The applicant shall pass an examination, or examinations, administered by the Iowa DOT to obtain the certification level desired.

Out-of-state applications should be submitted to the Iowa DOT Materials Office in Ames to schedule test dates. Copies of all certifications must accompany the application.

CERTIFICATION INFORMATION

Certification information is available in the Iowa Technical Training Booklet. The booklet contains information on the Technical Training Program and a description of all classes offered.

Class schedules for all technical training classes statewide and applications are also included. The booklets are available from any of the Iowa DOT Transportation Center Material Offices. They may also be obtained from the ICPA, IRMCA, ILPA, and APAI.

The fees for the schools and examinations are indicated in the booklet.

INSTRUCTIONAL SCHOOLS AND EXAMINATIONS

The Transportation Center Office of Materials will conduct schools and provide the study materials. Producers/contractors are encouraged to conduct their own pre-training programs. All new applicants must attend an Iowa DOT school and pass the applicable exams to become certified. All examinations will be conducted by the Materials Offices.

The locations and dates of examinations are found in the Technical Training and Certification Registration Booklet. The Level I examination will cover the fundamentals of sampling. The Level II examination will cover the fundamentals of sampling, testing, reporting and proper inspection control as well as a hands-on practical demonstration.

Both the Level I and Level II exams will be open book. Each applicant will have the opportunity to retake any part of the examination failed. If, over a six month period, an applicant fails to successfully complete both portions of the Level II examination, the applicant must retake and successfully pass both portions of the examination.

CERTIFICATION

Upon successfully completing the requirements for certification, the Program Director will issue a certificate and a pocket certification card. This certification is not transferable.

PERFORMANCE REQUIREMENTS

A written notice may be issued to the certified technician for any inadequacies in performing his/her duties. Upon receipt of two such notices, the certified technician may be given a three month suspension. After three written notices, the certified technician is subject to decertification.

DECERTIFICATION

The certificate will become invalid for reasons such as:

1. Failure of the certificate holder to renew the certificate prior to regular expiration described above.
2. False or fraudulent information being used to secure or renew the certificate.
3. False or fraudulent actions or documentation by the certificate holder.

RENEWAL OF CERTIFICATION

Certifications will remain valid for five (5) years (a three month grace period will be allowed). If the individual has not renewed their certification within the 90 day grace period they are automatically decertified. The individual may obtain certification by taking the examination for the level of certification they are requesting. If the individual does not take the examination within one year from the date of decertification, they must retake all applicable schools and pass the examinations. **The responsibility for applying for recertification shall rest with the certified individual.**

It shall be the responsibility of the individual to inform the Office of Materials of any address change.

Note: The new program will be implemented at the expiration date of an individual's current certification.

Retesting will be required every five years regardless of work experience or performance. Failure of any level shall require the applicant to retake the applicable school and pass the test.

FUNCTIONS AND RESPONSIBILITIES

The specification requirement for source gradation testing by Certified Technicians does not change the supplier's responsibilities to furnish materials complying with the specification requirements.

The sampling and testing of aggregates for gradation at each source shall be performed by a Certified Technician. The technician shall sample and test in accordance with specified frequencies and promptly submit designated reports.

The Transportation Center Materials Engineer will be responsible for monitoring product quality control and the sampling and testing of aggregates for gradation by the Certified Technician. It is the responsibility of the aggregate producer to maintain the quality of the product delivered to the project.

Samples for abrasion, freeze and thaw, and other tests as needed to monitor the quality control of aggregates will be obtained by Transportation Center Materials Engineers' Offices. Copies of this test data will be made available to the producer by the Transportation Center Materials Office for their records.

The Transportation Center Materials Office will have the authority and responsibility to question and, where necessary, require any changes in production or quality control to ensure the production of material which consistently complies with specification requirements.

Iowa Department of Transportation
HIGHWAY DIVISION - OFFICE OF MATERIALS
INSTRUCTIONAL MEMORANDUM

November 1994
Supersedes November 1993

Matls. I.M. 209
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CERTIFIED AGGREGATE TESTING
AND
CERTIFIED AGGREGATES
General Rewrite

GENERAL

The prime contractor or a contractor's authorized representative (the producer) shall be responsible for source product quality control.

Aggregate source gradation testing will be performed and documented in accordance with this Instructional Memorandum by persons qualified in accordance with the provisions of I.M. 210.

Source gradation tests will be considered advisory when the aggregate is used for portland cement concrete, asphaltic concrete, asphalt treated base, bituminous treated base, and cement treated granular base and may be considered the basis of acceptance for all other aggregates. The advisory tested group will hereinafter be called "proportioned aggregates." The gradation tests will be called certified gradation tests and the aggregate represented will be called certified aggregate.

Sampling and testing duties described in this Instructional Memorandum shall not be delegated to noncertified technicians.

SAMPLING, TESTING AND DOCUMENTATION

Certified source testing shall be performed as outlined in Materials I.M. 204 utilizing the procedures contained in Materials I.M. Series 300. This testing shall be performed at the required frequency (I.M. 204) during production. Additional certified gradation testing may be required at the time material is shipped to a project or for a stockpiled material carried through a winter season. When additional certified testing of stockpiled material is required, the testing shall be at a frequency of at least one per 6000 Mg (tons). Bins or other means of securing representative samples shall be furnished for the sampling of stockpiled material.

The quality of the material produced shall be verified by testing before shipment to a project. Quality samples will be secured by Transportation Center Materials Office personnel.

All producer gradation tests, complying or non-complying, performed on certified aggregates shall be transmitted promptly by the aggregate producers to the Transportation Center Materials Office on Form 821278. The certified test reports shall identify whether the material is being produced for direct delivery or stockpiling for a specific project or for advance warehouse stock.

Source information and production limits shall be documented on Form 955 for aggregate used in all asphalt mixtures whether the aggregate is being produced directly for project mix designs or secured from acceptable warehouse stockpiles. For other aggregates, the production limits selected need be documented only on the certified gradation test report (Form 821278).

To insure proper identification of delivered aggregates each truck load of certified aggregate shall be identified by a numbered truck ticket showing aggregate description (which shall include the Iowa DOT gradation number if appropriate, the product size if being used for an asphalt mixture, etc.), quantity, source (the pit or quarry name), delivery date and the following certification statement:

This is to certify the material herein described meets applicable contract specification and requirements.

Note: This certification statement shall be signed or initialled by an authorized representative of the Producer.

Note: For aggregates as bid items measured by mass (weight), certified tickets shall include signatures or initials in accordance with Article 2001.07. For aggregates as bid items not measured by weight, a shipment statement or a copy of the certified gradation test report (Form 821278), (which shall include the Iowa DOT gradation number if appropriate, the product size if being used for an asphalt mixture, etc., quantity, source [the pit or quarry name], delivery date and the above certification statement) shall be furnished to project inspection personnel. A certified truck ticket may also be furnished.

When aggregate is shipped by rail or barge each shipment must be identified by a bill of lading or shipment listing which includes rail car or barge number, aggregate description (which shall include the Iowa DOT gradation number if appropriate), quantity, and source and the above statement of certification. A copy of the bill of lading or shipment listing shall be sent to the project engineer and receiving contractor or ready mix operator no later than the same day as shipment source departure.

When aggregate is transferred to a paving plant or ready mix plant without being weighed the estimated quantity transferred shall be shown on a transfer listing furnished to the contractor or ready mix operator. This transfer listing shall include estimated quantity, aggregate description (which shall include the Iowa DOT gradation number), and source and the above statement of certification. An example of this situation is when aggregate moves from the source into a paving plant or ready mix plant without changing ownership.

Certified aggregate may be incorporated into a project on the basis of the certified truck ticket, certified bill of lading, shipment listing, certified transfer listing, or certified gradation test report (Form 821278). When the material represented is nonproportioned aggregate the project number must show on the certified document and a copy furnished for project inspection personnel. When the aggregate represented is proportioned aggregate the project number is preferred when practical as in the case when shipping to a paving plant site and not required when impractical as in the case when shipping into warehouse stock at a ready mix plant. A file of certified shipment or transfer documents for proportioned aggregate will be maintained by the contractor or ready mix operator and made available for inspection at each plant or project site during the project period. Project inspection personnel shall verify that all material incorporated in the project is properly certified and document this verification and quantity on each of the appropriate daily or periodic construction reports. No other project documentation for the incorporated aggregate is required.

Documentation procedures for asphalt and concrete paving plants which have multi project and commercial mix responsibilities would function in the same manner as described above for ready mix plants.

MONITORING OF CERTIFIED AGGREGATES

The Transportation Center Materials Office will be responsible for monitoring of sampling and testing of aggregates for gradation by the certified technician.

Sampling for monitor inspection of aggregate being produced for a project, for reserved stockpiles, or for stockpiles for intermittent project usage, will be secured at a minimum rate of one per 12,000 Mg (tons) for quality and one per 6,000 Mg (tons) to verify that the gradation testing is being performed in accordance with requirements. Note: These sampling frequencies may be adjusted by the Transportation Center Materials Engineer. The monitoring of certified gradation testing may be waived when the quantities required are approximately 2,000 Mg (tons) or less.

A notice of intent to start production of certified aggregates shall be given to the appropriate Transportation Center Materials representative to afford the opportunity to verify proper ledge control.

Periodic evaluation of certified technicians will be performed by the Transportation Center Materials Representative and kept on file. Correlation (split-bucket) sample results will be compared per I.M. 216.

At no time will the Transportation Center Materials Office representative issue directions to the producer. However, the representative will have authority and responsibility to question and where necessary reject any operation which is not in accordance with the specifications, special provisions and instructional memorandums.

REHANDLING OF CERTIFIED AGGREGATES

When certified aggregates are rehandled the Transportation Center Materials Engineer shall be notified and afforded the opportunity to monitor the rehandling procedure.

For the purpose of this I.M., rehandling is meant to include the physical unloading and reloading of aggregate at a temporary storage site before the aggregate is delivered to its final destination. Rehandled certified aggregates may be required to be retested with or without reweighing and recertified on a numbered shipment ticket with proper identification and certification statement.

ACCEPTANCE

In the case of proportioned aggregates acceptance tests will be performed on samples obtained at the proportioning plant in accordance with Construction Procedures and Instructions Manual Section 3.22 and Materials Instructional Memorandums 204 and 513.

Acceptance of nonproportioned aggregates will be based on certified gradation tests and on visual examination by the contracting authority to ensure against obvious contamination, segregation or similar unsatisfactory features.

Minor quantities of noncritical aggregates may be visually inspected by the contracting authority and recorded in the project field book. Monitor tests will not be required. Quantities less than 200 Mg (ton) are considered minor. An example of a noncritical aggregate is a nonproportioned aggregate such as granular backfill material for bridge abutments.

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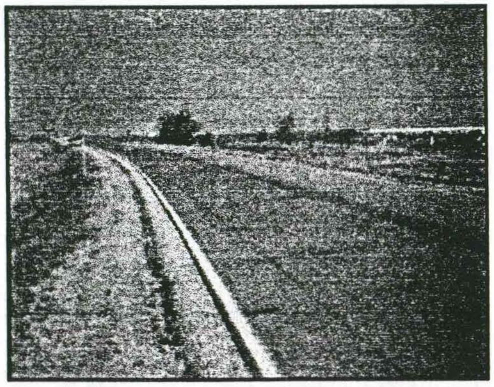
SECTION I
AGGREGATES

Today's highways must have the strength and durability to sustain high volumes of traffic for many years. Since the 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 which have been determined through experience to be the best measure of their quality.



Iowa has come close to eliminating the D-Cracking problem in primary pavements with the classification of coarse aggregates used in concrete.

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 particles and can be used as construction material. However, the term "aggregate" as used in this booklet will be referring to granular materials which contain, at most, only a few percent of particles which will pass through a 75 μm (#200) sieve.

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

Coarse and Fine Aggregates: Aggregates are frequently referred to as "fine" or "coarse." There is no universally accepted particle size which 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 aggregate." All particles which are retained on 4.75 mm (#4) or larger sieves are referred to as "coarse aggregate."

AGGREGATE CLASSIFICATION

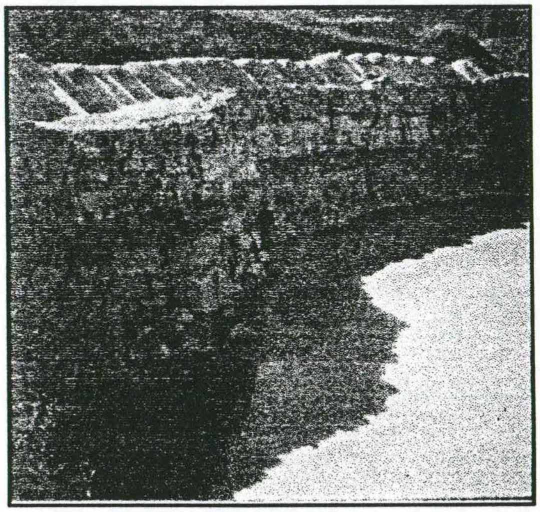
COARSE AGGREGATE: *Any aggregate that does not pass the 4.75mm (No. 4) sieve.*

FINE AGGREGATE: *Any aggregate that passes the 4.75mm (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 which 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.



Aggregate sources are generally gravels and crushed stone from rock sources such as quarries.

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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 require 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.

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SECTION II

SAMPLING METHODS AND EQUIPMENT

INTRODUCTION

This chapter deals with the different sampling methods and equipment. Before beginning to study, be sure you have a copy of the current I.M. Volume II prepared by the Materials Office of the Project Development 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 <u>must</u> know how to obtain a proper sample. Without

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

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this knowledge, it is useless to proceed further into the areas of test procedure.

SAMPLING FREQUENCY

Refer to Materials I.M. 204 in the Field Testing Manual.

In the Appendixes A through V of I.M. 204 are listed the minimum sampling frequencies of each material for various types of projects. More frequent sampling may be required for low or intermittent production or for widely varying test results.

SIZE OF SAMPLE

Refer to Materials I.M. 301 in the Field Testing Manual.

You will note on Page 2 of I.M. 301 a list of the various construction materials. Immediately to the right of each material listed is a minimum sample size which must be secured for each field sample.

RANDOM SAMPLING

Test samples should represent the total of the material being produced. 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 judgment sample and not a random sample. Random samples are taken when the plant is operating at the usual rate for that plant.

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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 run 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

METHODS FOR OBTAINING AGGREGATE SAMPLES:

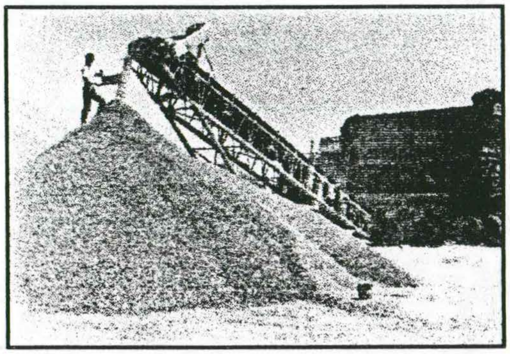
- *Off -the-Belt Sampling*
- *Streamflow Sampling*
- *Stockpile Sampling*
  (Fine Aggregate only)

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

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 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.

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

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



Aggregate technician obtaining streamflow sample.

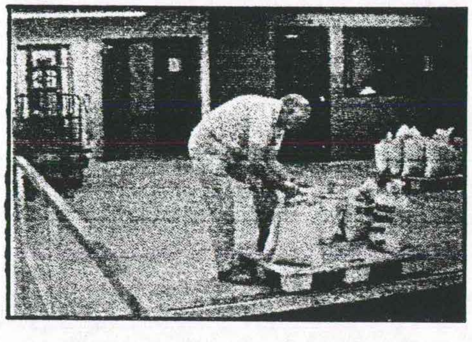
Stockpile sampling of fine aggregate may be accomplished by either using a shovel or a sand probe. When obtaining a field sample by the stockpile method, a minimum of three increments at different locations around the pile shall be taken. Care should be used not to sample at the bottom of the stockpile.

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

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

SAMPLE RECORDS

It is the responsibility of the aggregate sampler to get all the necessary information to fill out reports properly. Some of this information is general and is used 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.



Materials Technician checking in aggregate samples at the Central Lab of the Iowa DOT.

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 820003 should be filled out completely and placed <u>inside</u> the sample sack. Other identification tags should be attached to the tie for shipping information.

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?

NOTES

GENERAL AGGREGATE SOURCE INFORMATION

GENERAL

Generally, only those sources which have been sampled or tested within the last ten years are listed. This listing additionally ranks sources in accordance with a frictional classification as defined herein for aggregates used in asphalt construction, and a durability class for coarse aggregates used in portland cement concrete construction. Upon request, new sources or different combinations of beds within an existing source can be evaluated for classification for either type of use. These rankings do not in any way waive the normal quality requirements for the particular types of aggregates indicated in contract documents.

PORTLAND CEMENT CONCRETE AGGREGATES

Aggregates shall be produced from sources approved in accordance with the requirements of Materials I.M. 409. Scalping of some portion of the coarser fraction may be approved by the Engineer.

All aggregates produced and inspected for intended use in contracts under Iowa Department of Transportation Specifications shall be stored in identifiable stockpiles unless they are being delivered as produced.

DURABILITY CLASSIFICATION

The coarse aggregates have been divided into three classes in accordance with their durability level as determined by performance or laboratory testing.

Class 2 durability aggregates are those which are associated with no deterioration of pavements in less than 10 years and only minimal deterioration in pavements of 10 to 20 years of age. When performance records are unavailable the aggregates, when tested, must have durability factors of 80 or more.

Class 3 durability aggregates are those which are associated with little or no deterioration of pavements more than 20 years of age. When performance records of 20 years or more are unavailable the aggregates, when tested, must have durability factors of 90 or more.

Class 3i durability aggregates are those which are associated with only minimal deterioration on interstate system pavements from 20 to 30 years of age. When performance records are unavailable the aggregates , when tested, must possess the same properties as aggregates with acceptable performance histories.

Note: Those sources with a 'B' in their durability class designation may have 1/2" Bridge Deck Overlay/Repair material available.

ASPHALTIC CONCRETE AGGREGATES

Aggregates for asphaltic construction have been classified into six main functional types in accordance with their frictional characteristics. Those aggregates with the potential to develop the greatest amount of friction under traffic conditions are classified as Type 1 with the potential for friction decreasing as the type number increases. One or more friction types may be specified for use in pavement surface courses. If a type is not specified in the contract documents, Type 5 or better will be acceptable.

When aggregates of friction Type 1 through Type 4 are specified for construction, a source approval including bed limitations, is required for each project. Tentative bed limitations are shown in this publication.

The frictional classification types are listed and defined in order of descending quality as follows.

Type 1 Aggregates which are generally a heterogeneous combination of minerals with coarse grained microstructure of very hard particles (generally, a Mohs hardness range of 7 to 9) bonded together by a slightly softer matrix. These aggregates are typified by those developed for and used by the grinding-wheel industry such as calcined bauxite (synthetic) and emery (natural). They are not available from Iowa sources. Due to their high cost, these aggregates would be specified only for use in extremely critical situations.

Type 2 Natural aggregates in this class are crushed quartzite and granites. The mineral grains in these materials generally have a Mohs hardness range of 5 to 7. Synthetic aggregates in this class are some air-cooled steel furnace slags and others with similar characteristics.

Type 3 Natural aggregates in this class are crushed traprocks, and/or crushed gravels. The crushed gravels shall not contain more than 60 percent total carbonate. Synthetic aggregates in this class are the expanded shales with a Los Angeles abrasion loss less than 35 percent.

Type 4 Aggregates crushed from dolomitic or limestone ledges in which 80 percent of the grains are 20 microns or larger. The mineral grains in the approved ledges for this classification generally have a Mohs hardness range of 3 to 4. For natural gravels, the Type 5 carbonate (see below) particles, as a fraction of the total material, shall not exceed the noncarbonate particles by more than 20 percent.

Type 4D A subgroup of the Type 4 category comprised of those aggregates near but exceeding the 20 micron minimal grain size. Type 4D aggregates are not acceptable for use in sprinkle treatment or in any asphalt cement concrete surface courses requiring the use of Type 4 or better material.

Type 5 Aggregates crushed from dolomitic or limestone ledges in which 20 percent or more of the grains are 30 microns or smaller. This classification also includes natural gravels where the number of lithographic and sublithographic carbonate particles, expressed as a fraction of the total material, exceeds the noncarbonate particles by more than 20 percent.

SOURCE LISTINGS - Explanation

The use of X's in the PCC or AC columns indicates use where no classification is required or, if required, has not been made.

Note - indicates top size limitation.

Bed numbers shown for PCC aggregate are those on the formal source approval letter. Beds shown for AC sources are those which have been used or have potential for use and are of the designated friction type.

Frictional Classification - as indicated on page 2
Asphaltic Concrete - Type A and B

Durability Class for Portland Cement Concrete
Coarse Aggregate Fine Aggregate
('B' indicates acceptability for Bridge Deck Overlay/Repair)

Source Code Number - Used to identify sources on test requests and for data storage.

Specific Gravity
(DWU-Determine When Used)

```
                                                                                       DUR     FRICT
                                                                                 SP    PCC      AC
 CODE     OPERATOR                   SOURCE NAME                 LOCATION        GR    CA  FA  A  B   BEDS
**************************************************************************************************************
 04    APPANOOSE      SEITC      ---CRUSHED STONE---                                  :      :      :        :
A04004 L&W QUARRIES INC           MARTIN #3                    E2 20 T070  R19W 2.70 : 2    : 4D 4D: 1 - 3 :1
**************************************************************************************************************
 54    KEOKUK         SEITC      ---CRUSHED STONE---                                  :      :      :        :
A54002 KASER CORP                 KESWICK                      NW 21 T077  R12W 2.61 : 2    : 4  4 :13 -15 :2
**************************************************************************************************************
 55    KOSSUTH        NEITC      ---SAND & GRAVEL---                                  :      :      :        :
A55520 GIESE CONST CO             CONN                         SE 35 T095  R29W DWU  :   X  :      :        :3
**************************************************************************************************************
 56    LEE            SEITC      ---CRUSHED STONE---                                  :      :      :        :
A56004 CESSFORD CONST CO          FRANKLIN                     NE 25 T068  R06W 2.49 : 2    :      :     12 :2
**************************************************************************************************************
NOTES: 1 - AASHTO D-67, GRADATION #5, 40% MAXIMUM
       2 - AASHTO 57 GRADATION MAXIMUM
       3 - APPROVED ONLY FOR L-MIX PC CONCRETE
```

```
                                   RECENTLY ACTIVE
                                  AGGREGATE SOURCES

                                                                                   DUR    FRICT
                                                                            SP     PCC     AC
 CODE   OPERATOR                     SOURCE NAME          LOCATION          GR    CA FA   A  B  BEDS
*****************************************************************************************************
 01     ADAIR          DIST  4       ---CRUSHED STONE---                         :       :      :       :
A01002 SCHILDBERG CONST CO INC      MENLO                SE 17 T077  R31W        :       : 5  5 :15 -16 :
                                                                                 :       :    4 :    14 :
A01004 SCHILDBERG CONST CO INC      JEFFERSON            NW 17 T077  R31W        :       :    5 :    20 :
                                                                                 :       :    4D:    25 :
A01006 SCHILDBERG CONST CO INC      HOWE                 SW 01 T076  R31W        :       :    5 :    25 :
*****************************************************************************************************
 02     ADAMS          DIST  4       ---CRUSHED STONE---                         :       :      :       :
A02002 SCHILDBERG CONST CO INC      MT ETNA              SW 23 T073  R34W        :       :    4 :11 -13 :
A02004 SCHILDBERG CONST CO INC      CORNING                 10 T071  R34W        :       :    4 : 3 - 5 :
                                    ---SAND & GRAVEL---                          :       :      :       :
A02502 SCHILDBERG CONST CO INC      MT ETNA              NW 23 T073  R34W 2.67 : 2     : 4  4 :       :
                                                                          2.67 :     X :      :       :
*****************************************************************************************************
 03     ALLAMAKEE      DIST  2       ---CRUSHED STONE---                         :       :      :       :
A03002 BRUENING ROCK PROD INC       WEXFORD              NE 36 T098  R03W 2.70 : 31    :      : 1C- 5 :
                                                                                 :       : 4  4 : 1 - 8 :
A03008 BRUENING ROCK PROD INC       MCCABE               NE 06 T097  R05W        :       :    4 : 1 - 6 :
A03014 BRUENING ROCK PROD INC       HAMMELL-BOONIES      SW 02 T099  R06W        : X     : X  X :       :
A03022 ROVERUD CONST INC            LIVINGOOD            SW 07 T096  R06W        :       : 4  4 : 4 - 7 :
                                                                                 :       :    4 : 2 - 7 :
A03034 BRUENING ROCK PROD INC       WILDE                SE 13 T099  R05W        : X     : 4  4 : 1 - 5 :
A03038 BRUENING ROCK PROD INC       RHEIM                SE 07 T100  R04W DWU  : 31    : 4  4 : 1 - 4 :
A03040 BRUENING ROCK PROD INC       DEE                  SE 21 T099  R04W DWU  : 31B   : 4  4 : 5A- 5D:
A03042 BRESNAHAN CONST CO           CHURCHTOWN           SW 29 T099  R04W        :       :    4 : 1 - 3 :
                                                                                 :       : 4  4 :     3 :
A03046 BRUENING ROCK PROD INC       MOHS                 SW 29 T096  R04W DWU  : 2     : 5  5 : 1 - 2 :
                                                                                 :       :    5 : 1 - 4 :
A03048 BRUENING ROCK PROD INC       POSTVILLE            SW 16 T096  R06W        :       :    4 : 2 - 5 :
A03050 BRUENING ROCK PROD INC       GREEN                NW 16 T096  R06W 2.63 : 3     : 4  4 : 2 - 3 :
A03052 BRUENING ROCK PROD INC       ROSSVILLE            NW 36 T097  R05W        :       : X  X : 1 - 5 :
A03054 BRUENING ROCK PROD INC       WEST RIDGE           NE 08 T098  R06W        :       :      :       :
A03056 BRESNAHAN CONST CO           WAUKON               SW 05 T097  R05W        :       :      :       :
                                    ---SAND & GRAVEL---                          :       :      :       :
A03502 CARLSON MATERIALS CO         HARPERS FERRY        SW 07 T097  R02W 2.67 : 31B   : 3  3 :       :
                                                                          2.67 :     X :      :       :
A03506 BRUENING ROCK PROD INC       HAMMELL-BOONIES      SW 02 T099  R06W        :       : 4  4 :       :
A03510 CARLSON MATERIALS CO         LONNING              SE 02 T099  R06W        :       : 4  4 :       :
                                                                          DWU  :     X :      :       :
A03512 ROVERUD CONST INC            ZEZULKA              NE 11 T100  R04W        :       : 3  3 :       :
                                                                          2.66 :     X :      :       :
*****************************************************************************************************
 04     APPANOOSE      DIST  5       ---CRUSHED STONE---                         :       :      :       :
A04004 L&W QUARRIES, INC            LEMLEY WEST #3       E2 20 T070  R19W 2.70 : 2 .   : 4D 4D: 1 - 3 :1
                                                                                 :       :    5 :     6 :
A04016 L&W QUARRIES, INC            LEMLEY EAST #5       CT 35 T070  R19W 2.70 : 2     : 4D 4D: 1 - 3 :1
                                                                                 :       :    5 :     6 :
A04018 L&W QUARRIES, INC            CLARKDALE #8         SE 15 T069  R18W        :       :    5 :     4 :
                                    ---SAND & GRAVEL---                          :       :      :       :
A04502 MARTIN MARIETTA              CINCINNATI           NE 13 T067  R19W        :       : 4  4 :       :
                                                                          2.68 :     X :      :       :
*****************************************************************************************************
NOTE:
  1 - AASHTO D-67, GRADATION #5, 40% MAXIMUM
      RESTRICTION DOES NOT APPLY TO STRUCTURAL CONCRETE
```

CODE	OPERATOR	SOURCE NAME	LOCATION	SP GR	DUR PCC CA	DUR PCC FA	FRICT AC A	FRICT AC B	BEDS
05	AUDUBON DIST 4	---SAND & GRAVEL---							
A05506	HALLETT MATERIALS CO	EXIRA	NE 07 T078 R35W						
06	BENTON DIST 6	---CRUSHED STONE---							
A06002	BASIC MATERIALS CORP	SMITH	NW 19 T086 R12W	2.65	2		4	4	21 -26
A06004	VULCAN MATERIALS CO	GARRISON A	SE 28 T085 R11W	2.67	2		4	4	6 -16
A06006	VULCAN MATERIALS CO	GARRISON B	NE 33 T085 R11W	2.64	2		4	4	6 -16
A06008	VULCAN MATERIALS CO	BALLHEIM	NE 17 T086 R12W					X	
A06012	COOTS MATERIALS CO INC	JABENS	SW 07 T085 R11W	2.64	2		4	4	12
							4	4	10 -12
A06014	VULCAN MATERIALS CO	VINTON-MILROY	S2 10 T085 R10W					4	
A06016	COOTS MATERIALS CO INC	COOTS	SW 36 T086 R11W					X	
A06018	VULCAN MATERIALS CO	PORK CHOP-EAST	NW 11 T085 R09W					X	
A06020	VULCAN MATERIALS CO	PORK CHOP-WEST	NE 10 T085 R09W						
A06022	VULCAN MATERIALS CO	LONG	SE 13 T084 R09W					X	
		---SAND & GRAVEL---							
A06502	VULCAN MATERIALS CO	VINTON-MILROY	S2 10 T085 R10W				4	4	
				2.65		X			
A06504	COOTS MATERIALS CO INC	MT AUBURN	SW 31 T086 R10W				4	4	
				2.65		X			
A06506	VULCAN MATERIALS CO	PORK CHOP	CT 11 T085 R09W				4	4	
				DWU		X			
07	BLACK HAWK DIST 2	---CRUSHED STONE---							
A07002	BASIC MATERIALS CORP	RAYMOND-PINTS	SW 36 T089 R12W				4	4	5 -10
							4	4	20 -23
							4	4	18 -27
								4	11 -17
A07004	BASIC MATERIALS CORP	WATERLOO SOUTH	NW 18 T087 R12W				4	4	17 -23
							4	4	32 -36
								4	1 -16
A07006	BASIC MATERIALS CORP	YOKUM	NE 05 T090 R14W					5	11 -21
A07008	BASIC MATERIALS CORP	MORGAN	NE 15 T089 R12W					5	1 - 3
								5	4A- 4B
A07014	NIEMANN CONST CO	GLORY	NE 36 T087 R11W					4	3 - 4
								5	1 - 4
A07016	BASIC MATERIALS CORP	AHLES	NE 13 T088 R11W	2.60	3i		4	4	1A- 1B
A07018	BASIC MATERIALS CORP	RAYMOND-PESKE	SW 01 T088 R12W	2.65	2		4	4	1B- 5
							4	4	6 -10
A07020	BASIC MATERIALS CORP	STEINBRON	SE 01 T088 R11W	DWU	3i		X	X	1
		---SAND & GRAVEL---							
A07504	BASIC MATERIALS CORP	WATERLOO SAND	SW 09 T089 R13W				4	4	
				2.65		X			
A07506	MANATTS INC	ASPRO	NW 01 T088 R13W				4	4	
				2.65		X			
A07508	HAWKEYE MATERIALS	LIVINGSTON	16 T088 R12W				4	4	
				2.65		X			
A07510	BAGENSTOS S&G	BAGENSTOS & SON	SE 19 T087 R11W				4	4	
				2.65		X			
08	BOONE DIST 1	---SAND & GRAVEL---							
A08520	MARTIN MARIETTA	LAUBE	36 T085 R27W				4	4	
A08524	HALLETT MATERIALS CO	JENKINS-STURTZ	W2 36 T084 R27W	2.70	2		3	3	
				2.67		X			

NOTES

INSPECTION OF CONSTRUCTION PROJECT SAMPLING AND TESTING

PURPOSE

The purpose of this memorandum is to prescribe general objectives, policies, procedures, and guide schedules for sampling and testing materials and construction. Sampling and testing guides for certain types of construction are attached as appendices to this memorandum.

OBJECTIVES

The objectives of sampling and testing are:

A. To determine through process control and/or acceptance sampling and testing whether the construction operations controlled by sampling and testing and materials used or proposed for use in the construction work are in reasonably close conformity with approved plans and specifications (including approved changes).

B. To provide checks or reliability of acceptance sampling and testing through independent assurance sampling and testing by personnel not normally responsible for process control or acceptance.

C. To provide opportunity for timely remedial action when results of sampling and testing indicate materials used or proposed for use and the construction work accomplished or in progress are not in reasonably close conformity with the approved plans and specifications (including approved changes).

PROCESS CONTROL AND/OR ACCEPTANCE SAMPLING AND TESTING

Process control and/or acceptance sampling and testing are required to ascertain on a day to day basis whether the quality of materials being incorporated into the construction and the quality of construction work in progress are in reasonably close conformity with the plans and specifications. Results of these tests constitute the principal means of determining daily if materials and construction are satisfactory, or whether corrective action should be taken before work proceeds further. They serve as the principal basis for determining the acceptability of completed construction.

Materials Inspection and Acceptance

In order to provide the contractor the opportunity to construct a project with minimal sampling and testing delays, inspection is performed at the source. Source inspection may consist of inspecting process control, sampling for laboratory testing or a combination of these procedures.

All source inspected or certified materials are subject to inspection at the project site prior to being incorporated into the work. Project site inspections are for identification of materials with test reports and for any unusual alterations of the characteristics of the material due to handling or other causes. Supplemental monitor samples secured by project personnel of source inspected, certified or project processed materials are also required for some materials in order to secure satisfactory evidence for acceptance.

Source Inspection

Materials with characteristics which do not easily change will normally be accepted at the time of incorporation into the work on the basis of complying source inspection test reports. This also applies to materials in which the packaging or form of shipment ensures proper identification of the materials and the original material characteristics.

Supplemental sampling and testing of source inspected material are required for some materials which are subject to change during delivery. This also applies to some materials which are difficult to identify with source inspection test reports. Except for unusual situations, the Contractor may, on the Contractor's responsibility and at the Contractor's risk, incorporate these materials into the work before completion of the required supplemental tests. Acceptance of these materials will be based on source inspection tests and tests of the supplemental samples.

In the case of aggregate quality, production from an approved source is required. The source approval includes the quality control operation and processing procedures established, and the ledges suitable for the production of crushed stone for the various quality requirements. Random source inspection is performed to detect any significant change in characteristics of a source and any variations of the established quality control and on processing procedures. Random sampling and testing are performed to monitor the quality of aggregate being produced from each source. For certain major types of construction, supplemental construction site assurance sampling and laboratory testing for quality are required in addition to the above quality control inspection and testing prior to acceptance. The Contractor may, on the Contractor's responsibility and at the Contractor's risk, incorporate these aggregates into the work before completion of supplemental tests. Acceptance for quality will be based on source monitoring and the test results on assurance and/or project samples. Source approval and monitor inspections and tests will be the basis for acceptance of other aggregates.

Certified aggregate gradation tests by a certified aggregate technician in accordance with the requirements of Materials I.M. 209 and 210, are required by paragraph 1106.01 of the Standard Specification.

Certified source aggregate gradation tests will be considered advisory when the aggregate is used for portland cement concrete, asphalt concrete, bituminous treated base, and cement treated granular base and will be considered the basis of acceptance for all other aggregates. The advisory tested group are called "proportioned aggregates" and the remaining groups are called "nonproportioned aggregates." The gradation tests are called certified gradation tests and the aggregates represented are called certified aggregates.

Certification Procedures

In the case of many materials it is more economical, efficient, and practical to require certification procedures in lieu of source inspection. Certified test results are required for some methods and only a certificate of compliance is required for other materials. The acceptance of some proprietary materials is on an approved source or brand basis.

For many of the materials for which certification procedures are required, supplemental testing of samples secured by project personnel and assurance samples secured by Transportation Center personnel are also required as part of the basis of acceptance. When certification procedures are required, the Contractor may, on the Contractor's own responsibility and at the Contractor's risk, incorporate these materials into the work. Acceptance will be based on satisfactory certification and compliance of the test results of any supplemental samples. When supplemental samples are not required, acceptance will be based on satisfactory certification.

The certificate of compliance shall be signed by an authorized representative of the company.

Small Quantities of Materials

When small quantities of construction materials are involved and the cost of sampling and testing would be excessive, or the performance of the material is not critical, visual inspection or compliance certificates may be the basis for acceptance.

Sampling & Testing Guides

The appended sampling & testing guides schedule indicates the minimum inspection, sampling and testing procedures required within the guide policy and procedures for the acceptance of materials and construction work. Note: There are two sets of sampling & testing guides - One in S.I. units (metric) and one in U.S. units (in./lb.).

PROJECT PLANT, FIELD LABORATORY AND GRADE INSPECTION AND ACCEPTANCE

The project inspectors shall identify and inspect all materials received on the project before the materials are incorporated into the work. They shall ascertain that proper inspection reports or certifications are on hand and that there have been no unusual alterations in the characteristics of the materials due to handling or other causes. In the event they are unable to properly identify the materials delivered or that materials were not inspected before delivery, the Transportation Center Materials Office shall be notified.

Project plant, field laboratory, and grade control acceptance sampling and/or testing will be performed by project personnel as outlined in the sampling and testing guides and all other applicable instructions. When certified plant inspection or Quality Management-Asphalt (QM-A) testing are provided by the Contractor, those gradation tests, and the asphalt mixture tests, shall be known as process control tests. The acceptance testing will be performed by the contract authority. Test results determined by the Transportation Center or Central laboratories which indicate specification non-compliance will be promptly reported to the Project Engineer's Office by telephone.

Acceptance gradation testing on projects with contractor provided certified plant inspection will be performed on samples split from process control samples. The sampling and splitting will be randomly witnessed by the contract authority.

A Noncompliance Notice (Form 830245) will be immediately delivered to the acting representative of the Contractor for the area of construction involved whenever project or laboratory test results indicate noncompliance with the specifications and/or plans. Appropriate action in accordance with specifications and instructional memorandums shall be taken.

ASSURANCE SAMPLING AND TESTING

Independent assurance inspection will be performed as a check on the reliability of material and project control acceptance sampling and testing. It is the responsibility of the Transportation Center Materials Engineer to provide this inspection as outlined herein and designated in the sampling and testing guides. In no case shall personnel assigned to this work have any direct responsibility for project process control.

Assurance samples of materials are required in some cases for testing to secure supplemental data for acceptance of source inspected or certified materials. The majority of the assurance samples are for validating project control sampling and testing.

Assurance sampling and testing required for project control testing shall be performed using test equipment other than that assigned to the project. Occasionally, for expedient situations, the project test equipment may be used. When specified in the appendices or when small quantities of materials are involved, the assurance sampling and testing may be accomplished by observation of the acceptance sampling and testing performed by personnel. When similar material is being incorporated into the work and processed through the same plant for more than one project, one assurance sample may be taken to represent those projects. Test results on the sample are to be reported to all projects represented by the sample.

Assurance Sampling and Testing for Incidental Concrete, as described in I.M. 528, is not required.

Assurance samples of materials for which project personnel are performing acceptance sampling and testing will normally be taken at approximately the same time and location as the project acceptance samples.

Samples of other materials which require laboratory testing are to be taken in accordance with the sampling and testing guides and appropriate instructions.

A report of the assurance tests, and the companion project acceptance, tests will be made by the individual performing the assurance tests and signed by the Transportation Center Materials Engineer. If there are any significant discrepancies between the test results, the report shall document the procedures used to evaluate and reconcile the differences.

The frequency of assurance sampling should be increased when it appears that the average values of the test results are approaching either an upper or lower specification limit. If the test results on assurance samples do not reflect the indicated quality of the material or if they are outside specification requirements, the Transportation Center Materials Engineer should be consulted promptly concerning the cause, degree, and necessity for correction. Additional samples may be necessary to determine the cause of the deviations.

The location and frequency of assurance samples are prescribed in the attached sampling and testing guides.

It is not always possible to coordinate the assurance sampling from projects where small quantities of materials are incorporated in a short period of time. In such cases, assurance samples may be waived by the Transportation Center Materials Engineer. However assurance sampling is encouraged when possible. Quantities below which assurance samples are not required are shown in the appropriate appendixes.

SAMPLING AND TESTING GUIDE SCHEDULES

The following guides prescribe the minimum frequency for sampling and testing, the indicated inspection locations and the size for each sample type. The guide frequencies are considered to be the minimum required for proper project documentation under normal construction conditions and procedures. More frequent sampling may be required by special conditions such as low or intermittent production, or widely varying test results, and must be initiated at the discretion of and by project inspection personnel. Test results reported via computer terminal may not be identified by a report form number.

> Note: In order to maintain as much clarity as possible in the Guide Schedules, the changes from the last issue are not marked. The Schedules should be checked carefully for changes.

I.M. 204 Appendixes

Appendix A	Roadway and Borrow Excavation and Embankments
Appendix B	Deleted
Appendix C	Deleted
Appendix D	Granular Subbase
Appendix E-1, E-2	Portland Cement Conc. Pavement, Pavement Widening, Base Widening, Curb and Gutter & Class 1 Shoulders
Appendix F-1, F-2	Type A Asphaltic Concrete
Appendix G-1, G-2	Type B Asphalt Concrete, Type B Asphaltic Concrete Base Subbase and Base Widening
Appendix H-1,	Structure Concrete, Reinforcement, Foundations. & H-2, H-3 Substructures, Conc. Struct., Conc. Floors & Conc. Box, Arch & Circular Culverts
Appendix I	Soil Aggregate Subbase
Appendix J	Soil Lime Subbase
Appendix K	Deleted
Appendix L	Granular Surfacing/Driveway Surfacing
Appendix M-1, M-2	Concrete Bridge Floor Repair & Overlay & Surfacing
Appendix P	Bituminous Seal Coat
Appendix Q	Deleted
Appendix R	Deleted
Appendix T-1, T-2	Base Repair 2212, Concrete Pavement Repair 2529 & 2530
Appendix U	Granular Shoulders
Appendix V	Subdrains

C - Central Laboratory
D - Dist. Laboratory
ASD - Approved Shop Drawings
AS - Approved Source
AB - Approved Brand

SAMPLING AND TESTING GUIDE
MINIMUM FREQUENCIES
PORTLAND CEMENT CONCRETE PAVEMENT, PAVEMENT WIDENING, BASE WIDENING, CURB AND GUTTER, AND CLASS 1 SHOULDERS
Section 2201, 2213, 2301 and 2302

U.S. Units

Materials Inst. Memorandums
Assurance Sample Secured by District Personnel at Project Site

MATERIAL OR CONSTRUCTION ITEM	TESTS	AS or AB	METHOD OF ACCEPTANCE OR SAMPLING & TESTING	PROJECT ACCEPTANCE SAMPLING AND TESTING							ASSURANCE SAMPLES AND TESTS			REMARKS
				FIELD SAMPLING AND TESTING			FIELD SAMPLING AND LAB TESTING							
				FREQUENCY	SAMPLE SIZE	RPT. NO.	FREQUENCY	SAMPLE SIZE	LAB.	RPT. NO.	FREQUENCY	SAMPLE SIZE	LAB	
SOURCE INSP.														
Aggregates														
Fine (4110) (4111)	Gradation		302-306	1/1500T	IM 301	821278								
	Delt. Matls.	AS	410											
Sp. Grav.		AS	307	Variable										
	Mortar St.	AS	410											
Coarse (4115)	Gradation		303-306	1/1500 T	IM 301	821278								
	Obj.Matls.	AS	415											
	F & T	AS	209-415											
	Abrasion	AS	209-415											
	Sp. Gravity	AS	307											
Port. Cement (4101)	Quality	AS	401											
Fly Ash	Quality	AS	491.17											
Curing Compounds A. (4105)	Lab Tested						1/lot (1)	1 qt.	C					A. Barrier Rails ASTM. 309 Cert. by Manuf.
Burlap (4104)	Lab Tested						1/shipment	1 sq. yd.	C					
Plastic Film (4106)	Lab. Tested						1/lot	3 ft. full width	C					
Mixing Water (4102)	Lab Tested						1/source	1 qt.	C					
Air Ent. Admix.(4103)	Quality	AB	403											
Water Reducing Admixture	Quality	AB	403											
Joint Sealer(4136.02)	Lab Tested						1/lot (1)	10 lbs.	C					
Subgrade Film(4107)	Lab Tested						1/lot (1)	3 ft. full width	C					
Steel Reinf. (4151):														
Dowels	Quality	AS	451											
Tie Bars	Quality	AS	451											
Cont. Reinf.	Quality	AS	451											
General Use	Quality	AS	451											
Wire Mesh(4151)	Lab Tested	AS	451											
Engineering Fabric. (4196)	Quality	AB	496.01											
PLANT INSP.														
Aggregates														
Fine	Gradation		302-306	3/lot	IM 301	830224					1/100,000 sq.yds.	IM 301	D	
	Moisture		308	1/½ day	1000 grams	830224								
	Sp. Gravity		307	variable	1000 grams	830224								
	Quality	AS	410											
Coarse	Gradation		303-306	3/lot	IM 301	830224					1/100,000 sq.yds.	IM 301	D	
	Moisture		308	1/½ day	2000 grams	830224								
	Sp.Gravity			variable	2000 grams	830224								
	Quality										1/100,000 sq.yds.	50 lbs.	C	
Port.Cement	Quality	AS	Cert.	Each Load		830224					1/100,000 sq.yds.	15 lbs.	C	
	W/C Ratio			1/1000 cy*		830224								*Min-1/day
	Delivery Check			1/10,000 cy		820912								
Fly Ash	Quality	AS	Cert.	Each Load		830224					1/100,000 sq.yds	15 lbs.	C	
Air Entraining Admixture (4103)*		AB	403				1/lot (1)	1 pt.	C	820259				Monitor Sample
Water Red. Admix.		AB	403				1/lot (1)	1 pt.	C					Monitor Sample

(1) Sample lots not previously reported or as required by Dist. Matl's Engr.

Pub 300-US-E1
5631 04/19/94

C - Central Laboratory
TC - Trans. Center. Laboratory
ASD - Approved Shop Drawings
AS - Approved Source
AB - Approved Brand

SAMPLING AND TESTING GUIDE
MINIMUM FREQUENCIES
PORTLAND CEMENT CONCRETE PAVEMENT, PAVEMENT WIDENING, BASE WIDENING, CURB AND GUTTER, AND CLASS 1 SHOULDERS

Section 2201, 2213, 2301 and 2302

Metric Units

Materials Inst. Memorandums
Assurance Sample Secured by Trans. Center Personnel at Project Site

MATERIAL OR CONSTRUCTION ITEM	TESTS	AS or AB	METHOD OF ACCEPTANCE OR SAMPLING & TESTING	PROJECT ACCEPTANCE SAMPLING AND TESTING							ASSURANCE SAMPLES AND TESTS			REMARKS
				FIELD SAMPLING AND TESTING			FIELD SAMPLING AND LAB TESTING							
				FREQUENCY	SAMPLE SIZE	RPT. NO.	FREQUENCY	SAMPLE SIZE	LAB.	RPT. NO.	FREQUENCY	SAMPLE SIZE	LAB	
SOURCE INSP.														
Aggregates														
Fine (4110) (4111)	Gradation		302-306	1/1500 Mg	IM 301	821278								
	Delt. Matls.	AS	410											
Sp. Grav.		AS	307	Variable										
	Mortar St.	AS	410											
Coarse (4115)	Gradation		303-306	1/1500 Mg	IM 301	821278								
	Obj.Matls.	AS	415											
	F & T	AS	209-415											
	Abrasion	AS	209-415											
	Sp. Gravity	AS	307											
Port. Cement (4101)	Quality	AS	401											
Fly Ash	Quality	AS	491.17											
Curing Compounds A. (4105)	Lab Tested						1/lot (1)	1 L	C					A. Barrier Rails ASTM. 309 Cert. by Manuf
Burlap (4104)	Lab Tested						1/shipment	1 m^2	C					
Plastic Film (4106)	Lab. Tested						1/lot	1 m full width	C					
Mixing Water (4102)	Lab Tested						1/source	1 L	C					
Air Ent. Admix.(4103)	Quality	AB	403											
Water Reducing Admixture	Quality	AB	403											
Joint Sealer(4136.02)	Lab Tested						1/lot (1)	4.5 kg	C					
Subgrade Film(4107)	Lab Tested						1/lot (1)	1 m full width	C					
Steel Reinf. (4151):														
Dowels	Quality	AS	451											
Tie Bars	Quality	AS	451											
Cont. Reinf.	Quality	AS	451											
General Use	Quality	AS	451											
Wire Mesh(4151)	Lab Tested	AS	451											
Engineering Fabric. (4196)	Quality	AB	496.01											
PLANT INSP.														
Aggregates														
Fine	Gradation		302-306	3/lot	IM 301	830224					1/100,000 m^2	IM 301	TC	
	Moisture		308	1/½ day	1000 grams	830224								
	Sp. Gravity		307	variable	1000 grams	830224								
	Quality	AS	410											
Coarse	Gradation		303-306	3/lot	IM 301	830224					1/100,000 m^2	IM 301	TC	
	Moisture		308	1/½ day	2000 grams	830224								
	Sp.Gravity			variable	2000 grams	830224								
	Quality										1/100,000 m^2	22 kg	C	
Port.Cement	Quality	AS	Cert.	Each Load		830224					1/100,000 m^2	7 kg	C	
	W/C Ratio			1/1000 m^3*		830224								*Min-1/day
	Delivery Check			1/10,000 m^3		820912								
Fly Ash	Quality	AS	Cert.	Each Load		830224					1/100,000 m^2	7 kg	C	
Air Entraining Admixture (4103)*		AB	403				1/lot (1)	0.5 L	C					Monitor Sample
Water Red. Admix.		AB	403				1/lot (1)	0.5 L	C					Monitor Sample

(1) Sample lots not previously reported or as required by Dist. Matl's Engr.

C - Central Laboratory
D - Dist. Laboratory
ASD - Approved Shop Drawings
AS - Approved Source
AB - Approved Brand

SAMPLING AND TESTING GUIDE
MINIMUM FREQUENCIES
PORTLAND CEMENT CONCRETE PAVEMENT, PAVEMENT WIDENING, BASE WIDENING,
CURB AND GUTTER, AND CLASS 1 SHOULDERS
Section 2201, 2213, 2301 and 2302

U.S. Units

Materials Inst. Memorandums
Assurance Sample Secured by District Personnel at Project Site

MATERIAL OR CONSTRUCTION ITEM	TESTS	AS or AB	METHOD OF ACCEPTANCE OR SAMPLING & TESTING	PROJECT ACCEPTANCE SAMPLING AND TESTING							ASSURANCE SAMPLES AND TESTS			REMARKS
				FIELD SAMPLING AND TESTING			FIELD SAMPLING AND LAB TESTING							
				FREQUENCY	SAMPLE SIZE	RPT. NO.	FREQUENCY	SAMPLE SIZE	LAB.	RPT. NO.	FREQUENCY	SAMPLE SIZE	LAB	
GRADE INSP.														
Chloride Solution	Concentration		373	1/day		830224								
Wire mesh	Quality	AS	451	Each ship. Cert.							IM 451	2 ft. x 2 ft.	C	
Steel Reinf.(4151):														
Dowels	Quality	AS	451	Each ship. Cert.							IM 451	2-18 in. pc.	C	
Tie Bars	Quality	AS	451	Each ship. Cert.							IM 451	2-18 in.pc.	C	
General Use	Quality	AS	451	Each ship. Cert.							IM 451	42 in.pc.	C	
Plastic Conc.	Air Content		318-327	1/1000 cy*(1)		830224					1/100,000 sq.yds.		D	(1) 1/100 c.y. for Transit Mix
	Slump		317-327	1/1000 cy*(1)		830224					1/100,000 sq.yds.		D	
	Grade Yield			1/1000 cy		830224								
	Beams		316-327-328	1/2000 cy**		830224								*Min - 1/day
	Thickness			As needed										**Min - 2/day
Hardened Conc.	Thickness		346-347	1/2000 s.y.*		1263					10% proj		D	*See specifications for variations
	Width			1/day		Diary								
	Smoothness**	•	Cert							1263	10% proj		D	**Qualified operator and equipment
	Comp. Strength		346				1/2000 sy		C		1/2000 sy		C	
	Air content										1/4000 sy			

Note: When certified plant inspection is provided by the contractor, the frequency of acceptance gradation testing shall be as follows: Test the first three (3) split samples of each aggregate tested for process control on each project (each mix on a.c. projects). Test at least ten percent (10%) of the split samples thereafter.

Note: The assurance gradation sample is to be split with the project engineer. This split sample is for correlation purposes and, if it's not a routine lot sample, should not be used for determining specification compliance of a lot. However, any noncomplying test result is to be resolved.

Assurance samples not required when mix quantity is less than 2,000 sq. yds.

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SAMPLING AND TESTING GUIDE
MINIMUM FREQUENCIES
PORTLAND CEMENT CONCRETE PAVEMENT, PAVEMENT WIDENING, BASE WIDENING, CURB AND GUTTER, AND CLASS 1 SHOULDERS

Section 2201, 2213, 2301 and 2302

Metric Units

Materials Inst Memorandums
Assurance Sample Secured by Trans. Center Personnel at Project Site

MATERIAL OR CONSTRUCTION ITEM	TESTS	AS or AB	METHOD OF ACCEPTANCE OR SAMPLING & TESTING	PROJECT ACCEPTANCE SAMPLING AND TESTING							ASSURANCE SAMPLES AND TESTS			REMARKS
				FIELD SAMPLING AND TESTING			FIELD SAMPLING AND LAB TESTING							
				FREQUENCY	SAMPLE SIZE	RPT. NO.	FREQUENCY	SAMPLE SIZE	LAB.	RPT. NO.	FREQUENCY	SAMPLE SIZE	LAB	
GRADE INSP.														
Chloride Solution	Concentration		373	1/day		830224								
Wire mesh	Quality	AS	451	Each ship: Cert.							IM 451	0.5 m x 0.5 m	C	
Steel Reinf.(4151):														
Dowels	Quality	AS	451	Each ship. Cert.							IM 451	2-450 mm pc.	C	
Tie Bars	Quality	AS	451	Each ship. Cert.							IM 451	2-450 mm pc.	C	
General Use	Quality	AS	451	Each ship. Cert.							IM 451	2 m pc.	C	
Plastic Conc.	Air Content		318-327	1/1000 m^3*(1)		830224					1/100,000 m^2		TC	(1) 1/100 m^3 for
	Slump		317-327	1/1000 m^3*(1)		830224					1/100,000 m^2		TC	Transit Mix
	Grade Yield			1/1000 m^3		830224								
	Beams		316-327-328	1/2000 m^3**		830224								*Min - 1/day
	Thickness			As needed										**Min - 2/day
Hardened Conc.	Thickness		346-347	1/2000 m^2*		1263					10% proj		TC	*See specifications
	Width			1/day		Diary								for variations
	Smoothness**		Cert.							1263	10% proj		D	**Qualified operator and equipment
	Comp. Strength		346				1/2000 m^2		C		1/2000 m^2		C	
	Air content										1/4000 m^2			

Note: When certified plant inspection is provided by the contractor, the frequency of acceptance gradation testing shall be as follows: Test the first three (3) split samples of each aggregate tested for process control on each project (each mix on a.c. projects). Test at least ten percent (10%) of the split samples thereafter.

Note: The assurance gradation sample is to be split with the project engineer. This split sample is for correlation purposes and, if it's not a routine lot sample, should not be used for determining specification compliance of a lot. However, any noncomplying test result is to be resolved.

Assurance samples not required when mix quantity is less than 2,000m²

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AB - Approved Brand

SAMPLING AND TESTING GUIDE
MINIMUM FREQUENCIES
TYPE A ASPHALTIC CONCRETE
Section 2303

U.S. Units

Materials Inst. Memorandums
Assurance Sample Secured by District Personnel at Project Site

MATERIAL OR CONSTRUCTION ITEM	TESTS	AS or AB	METHOD OF ACCEPTANCE OR SAMPLING & TESTING	PROJECT ACCEPTANCE SAMPLING AND TESTING							ASSURANCE SAMPLES AND TESTS			REMARKS
				FIELD SAMPLING AND TESTING			FIELD SAMPLING AND LAB TESTING							
				FREQUENCY	SAMPLE SIZE	RPT. NO.	FREQUENCY	SAMPLE SIZE	LAB.	RPT. NO.	FREQUENCY	SAMPLE SIZE	LAB	
SOURCE INSP.														
Aggregates Coarse (4127)	Gradation Delt. Mtls. F & T Abrasion Absorption	 AS AS AS AS	303-304 308	1/1000T	IM 301	821278								
Fine (4127)	Gradation Clay & Silt Shale F & T (Lmst) Abr. (Lmst) Absorption	 AS AS AS AS	302 308	1/1000 T	IM 301	821278 821278								
Mineral Filler (4127)	AASHTO M-17 Gradation			1/lot	50 grams	821278								
Anti Strip Additive Hydratel Lime		AS	491.04											
Asph. Cement (4137)	Quality	AS	437											
Liquid Asphalt (4138) (4140)	Quality	AS	437											
Release Agent	Quality	AB	491.15											
PLANT INSP.														
Aggregates Combined Aggr. Moisture*	Quality Gradation	308	304 1/½ day	3/Lot* 1 kg.	IM 301 820007	820007					1/20,000 T 1/20,000 T	50 lbs. IM 301	C D	*Ref. to IM 508 page 35 (Lot) *Dryer Drum Plants
Sand Cover	Gradation	AS	302											
Asph. Cement	Quality Viscosity	AS	Cert. 323-361	Each Load	Log all shipments on Form	820007	1/40 T*	3 oz.	D D		1/20,000 T	1 qt.	C	*Test 1 sample/day
Cutback	Quality Viscosity	AS	Cert. 323-329	Each Load	Log all shipments on Form	820007	1/10,000 gal.	1 qt.	D		1/20,000 gal.	1 qt.	C	
Emulsion	Emulsion Residue		323-360				1/10,000 gal.	1 qt.	D					
Asph. Content %	Computed			Daily*	IM 509	820007								*As req. to det. pay quantities

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SAMPLING AND TESTING GUIDE
MINIMUM FREQUENCIES
TYPE A ASPHALTIC CONCRETE
Section 2303

Metric Units

Materials Inst. Memorandums
Assurance Sample Secured by Trans. Center Personnel at Project Site

MATERIAL OR CONSTRUCTION ITEM	TESTS	AS or AB	METHOD OF ACCEPTANCE OR SAMPLING & TESTING	PROJECT ACCEPTANCE SAMPLING AND TESTING							ASSURANCE SAMPLES AND TESTS			REMARKS
				FIELD SAMPLING AND TESTING			FIELD SAMPLING AND LAB TESTING							
				FREQUENCY	SAMPLE SIZE	RPT. NO.	FREQUENCY	SAMPLE SIZE	LAB.	RPT. NO.	FREQUENCY	SAMPLE SIZE	LAB	
SOURCE INSP.														
Aggregates Coarse (4127)	Gradation		303-304	1/1000 Mg	IM 301	821278								
	Delt. Mtls.	AS												
	F & T	AS												
	Abrasion	AS												
	Absorption	AS	308											
Fine (4127)	Gradation		302	1/1000 Mg	IM 301	821278								
	Clay & Silt					821278								
	Shale	AS												
	F & T (Lmst)	AS												
	Abr. (Lmst)	AS												
	Absorption	AS	308											
Mineral Filler (4127)	AASHTO M-17 Gradation			1/lot	50 grams	821278								
Anti Strip Additive Hydratel Lime		AS	491.04											
Asph. Cement (4137)	Quality	AS	437											
Liquid Asphalt (4138) (4140)	Quality	AS	437											
Release Agent	Quality	AB	491.15											
PLANT INSP.														
Aggregates	Quality										1/20,000 Mg	22 Kg	C	*Ref. to IM 508 page 33 (Lot)
Combined Aggr.	Gradation		304	3/Lot*	IM 301	820007					1/20,000 Mg	IM 301	TC	
Moisture*				1/½ day	1 kg.	820007								*Dryer Drum Plants
Sand Cover	Gradation	AS	302											
Asph. Cement	Quality	AS	Cert.	Each Load	Log all shipments on Form	820007					1/20,000 Mg	1 L	C	
	Viscosity		323-361				1/40 Mg*	85 g	TC					*Test 1 sample day
Cutback	Quality	AS	Cert.	Each Load	Log all shipments on Form	820007					1/76,000 L	1 L	C	
	Viscosity		323-329				1/38,000 L	1 L	TC					
Emulsion	Emulsion Residue		323-360				1/38,000 L	1 L	TC					
Asph. Content %	Computed			Daily*	IM 509	820007								*As req. to det. pay quantities

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SAMPLING AND TESTING GUIDE
MINIMUM FREQUENCIES
TYPE A ASPHALTIC CONCRETE
Section 2303

U.S. Units

Materials Inst. Memorandums
Assurance Sample Secured by District Personnel at Project Site

MATERIAL OR CONSTRUCTION ITEM	TESTS	AS or AB	METHOD OF ACCEPTANCE OR SAMPLING & TESTING	PROJECT ACCEPTANCE SAMPLING AND TESTING							ASSURANCE SAMPLES AND TESTS			REMARKS
				FIELD SAMPLING AND TESTING			FIELD SAMPLING AND LAB TESTING							
				FREQUENCY	SAMPLE SIZE	RPT. NO.	FREQUENCY	SAMPLE SIZE	LAB.	RPT. NO.	FREQUENCY	SAMPLE SIZE	LAB	
GRADE INSP.														
Uncompacted Mixture	AC Content		322-335				3/lot*	40 lbs	D	820975	1/20,000 T/mix	40 lbs.	C	*1/Lot less than 200 tons
	Gradation (1)		331								1/20,000 T/mix		C	
	Stability										1/20,000 T/mix		C	
	Lab. Density (Marshall)		321-325				1/day		D	820975	1/20,000 T/mix		C	
Compacted Mixture	Density		320-321	As spec.		820007					1/week			Test one set of cores IM 514
	Thickness		337	same		820007					1/proj.			
	Voids		321	same		820007					1/proj.			
	Width			same		Diary								
	Smoothness		Cert.								10%/proj.			*Qualified operator and equipment.
Reclaimed Asphalt Pavement	Extraction and Gradation		301 330 331				(1)							

(1) As required by District Materials Engineer

Note: When certified plant inspection is provided by the contractor, the frequency of acceptance gradation testing shall be as follows: Test the first three (3) split samples of each aggregate tested for process control on each project (each mix on a.c. projects). Test at least ten percent (10%) of the split samples thereafter.

Note: The assurance gradation sample is to be split with the project engineer. This split sample is for correlation purposes and, if it's not a routine lot sample, should not be used for determining specification compliance of a lot. However, any noncomplying test result is to be resolved.

Assurance samples not required when mix quantity is less than 1,000 tons.

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ASD - Approved Shop Drawings
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SAMPLING AND TESTING GUIDE
MINIMUM FREQUENCIES
TYPE A ASPHALTIC CONCRETE
Section 2303

Metric Units

Materials Inst. Memorandums
Assurance Sample Secured by Trans. Center Personnel at Project Site

MATERIAL OR CONSTRUCTION ITEM	TESTS	AS or AB	METHOD OF ACCEPTANCE OR SAMPLING & TESTING	PROJECT ACCEPTANCE SAMPLING AND TESTING							ASSURANCE SAMPLES AND TESTS			REMARKS
				FIELD SAMPLING AND TESTING			FIELD SAMPLING AND LAB TESTING							
				FREQUENCY	SAMPLE SIZE	RPT. NO.	FREQUENCY	SAMPLE SIZE	LAB.	RPT. NO.	FREQUENCY	SAMPLE SIZE	LAB	
GRADE INSP.														
Uncompacted Mixture	AC Content		322-335				3/lot (1) (2)*	18 kg	TC	820975	1/20,000 Mg/mix	18 kg	C	*1/Lot less than 200 Mg
	Gradation (1)		331								1/20,000 Mg/mix		C	
	Stability										1/20,000 Mg/mix		C	
	Lab. Density (Marshall)		321-325				3/lot (2)*		TC	820975	1/20,000 Mg/mix		C	
	Lab Voids		350-510				3/lot (2)*		820975				C	
Compacted Mixture	Density		320-321	As spec.		820007					1/week			Test one set of cores IM 514
	Thickness		337	same		820007					1/proj.			
	Voids		321	same		820007					1/proj.			
	Width			same		Diary								
	Smoothness		Cert.								10%/proj.			*Qualified operator and equipment
Reclaimed Asphalt Pavement	Extraction and Gradation		301 330 331				(1)							

(1) As required by Transportation Center

(2) Sample three per lot, test one per lot. On QMA projects the sampling rate is normally four per day. See I.M. 511 (QMA) for additional information on sampling and testing frequencies for QMA projects.

Note: When certified plant inspection is provided by the contractor, the frequency of acceptance gradation testing shall be as follows: Test the first three (3) split samples of each aggregate tested for process control on each project (each mix on a.c. projects). Test at least ten percent (10%) of the split samples thereafter.

Note: The assurance gradation sample is to be split with the project engineer. This split sample is for correlation purposes and, if it's not a routine lot sample, should not be used for determining specification compliance of a lot. However, any noncomplying test result is to be resolved.

Assurance samples not required when mix quantity is less than 1,000 Mg.

DETERMINATION OF MINIMUM SIZE OF SAMPLES FOR SIEVE ANALYSIS

SCOPE

This I.M. sets forth the minimum amount of dry materials necessary for the determination of particle size distribution.

LOCATION FOR SAMPLING

To help ensure 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) intercepting the complete material stream flow from the end of a conveyor belt or from overhead bin discharge, or 3) sampling from the production stockpile (for fine aggregate only or as directed by the Transportation Center Materials Engineer).

To obtain an off-the-belt sample: stop the belt, insert a template (as illustrated in Fig. 1) at three or more separate locations along the belt, remove all material within the template, and combine it into the sample. In belt sampling, the ends of the template should be spaced just far enough apart to get an increment that is approximately one-third the minimum mass (weight) of the sample. If the template does not yield the minimum size of sample in three locations, additional locations will be necessary. No less than three separate locations should be used in obtaining one sample.

When obtaining a sample by interception of the aggregate stream flow, care must be exercised so that the sampling device (see Fig. 2) passes quickly through the entire stream flow and does not overflow. At least three separate passes shall be made with the sampling device when obtaining a sample. Each pass is an increment of the sample. This is normally considered to be the best method to obtain a representative sample of coarse aggregate.

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 stockpile 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 Transportation Center Materials Engineer to help you devise an adequate sampling plan.

SHIPPING SAMPLES

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

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

SAMPLE SIZE & TEST METHODS

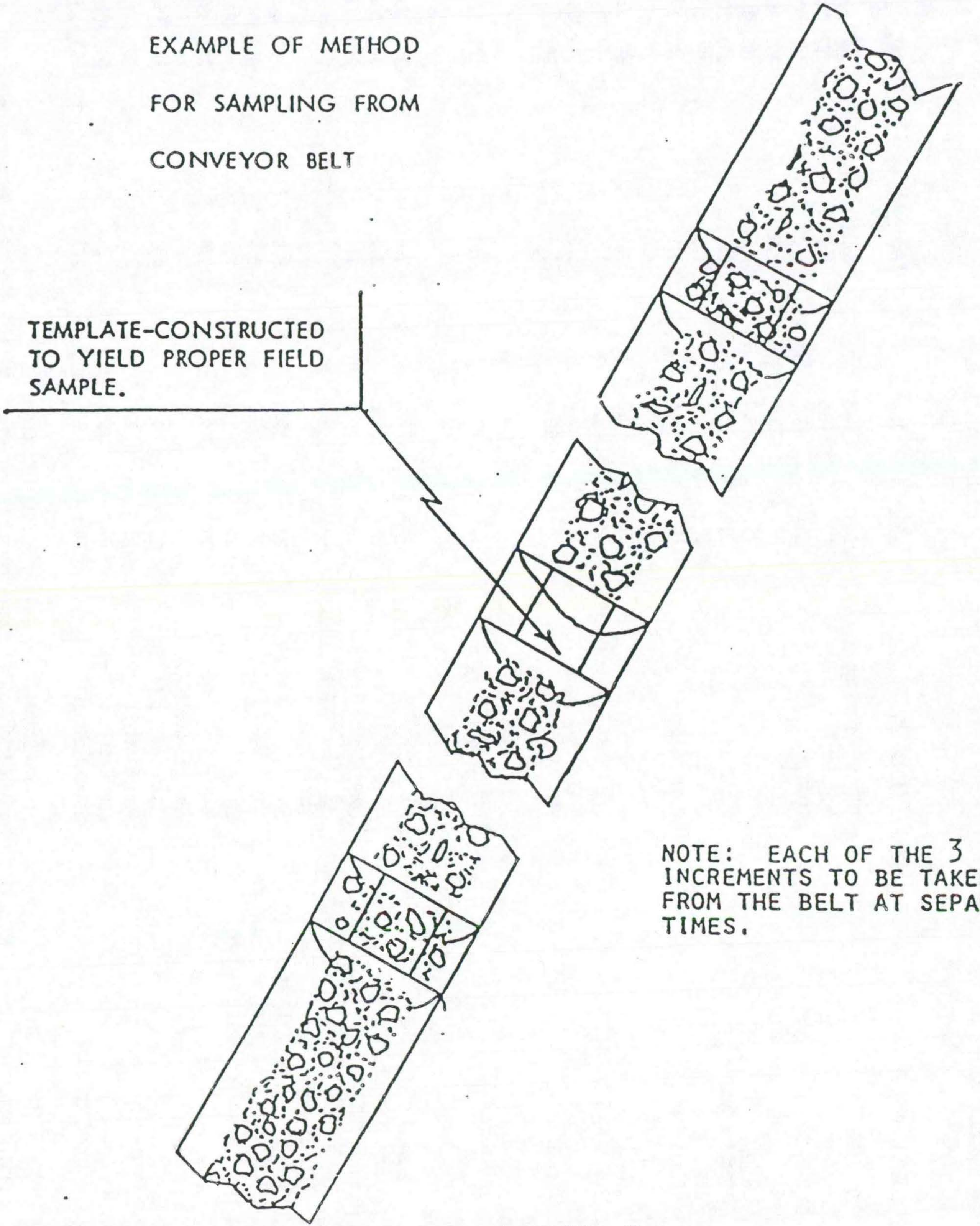
The sample size and test methods for the various materials shall be in accordance with the following schedule:

		Min. Field Sample			Min. Test
Gradation Number & Reference	Intended Use	lbs.	kg	Sample kg.	Matls. I.M.'s Required
1. 4110, 4111, 4125	PCC FA, Cover Agg.	10	4.5	0.5	302, 306, 336
2. 4112.	Mort Sand	10	4.5	0.1	302, 306, 336
3. 4115 (57,2-8)	PCC CA	30	13.5	5.0	303, 306, 336
4. 4115 (2-8)*	PCC CA	50	23.0	10.0	303, 306, 336
5. 4115 (67,2-8)	PCC CA	20	9.0	2.5	303, 306, 336
6. 4115.08 (repair & overlay)	PCC CA	20	9.0	2.5	303, 306, 336
7. 4117. (Class V)	FA & CA	10	4.5	1.0	302, 306, 336
8. 4117.03 (Class V add.)	Fine Lmst.	10	4.5	0.1	302, 306, 336
9. DELETED					
10. 4120 (C gravel)	Gran. Surf.	20	9.0	2.5	303, 306, 336
11. 4120, 4122.03 (A, B Cr. S)	Gran. Surf.& Shldrs.	20	9.0	2.5	303, 306, 336
12. 4121. **	Gran. Sub.	30	13.5	5.0	303,304,305,306,336
13. 4122.02 (Cr. Stone)	Mac. St. Base	35	16.0	15.0	303
14. DELETED					
15. DELETED					
16. 4122.04 (Cr. Stone)	Pvd. Shldr. File	50	22.5	10.0	303, 336
17. DELETED					
18. DELETED					
19. 4125. [13.2 mm (1/2" Cr.S)]	Cover Agg.	20	9.0	2.0	303, 306, 336
20. 4125. [13.2 mm (1/2" Gr.)]	Cover Agg.	20	9.0	2.0	303, 306, 336
21. 4125. [9.5 mm (3/8")]	Cover Agg.	10	4.5	1.0	303, 306, 336
22. 4127	ACC	20	9.0	2.5	303,304,305,306,336
23. 4125.01B (Cr. Stone)	Slurry Tr.				
24. 4126, 4127, 4128 [26.5 mm (1")] **	ACC	30	13.5	5.0	303,304,305,306,336
25. 4126, 4127, 4128 [19.0 mm (3/4") mix size] **	ACC	20	9.0	2.5	303,304,305,306,336
26. 4126, 4127 [13.2 mm (1/2") mix size] **	ACC	20	9.0	2.0	303,304,305,306,336
27. 4126,4127 [9.5 mm (3/8")]	ACC	10	4.5	1.0	302, 306, 336
28. 4129	Asph. Sand Surf.				
29. 4131	Porous Backfill	20	9.0	2.0	303, 336
30. 4132 (Cr. S) **	Spc. Backfill	20	9.0	2.5	303,304,305,306,336
31. 4132 (Gr.)	Spc. Backfill	20	9.0	2.5	303,304,305,306,336
32. 4133 (Sand/gravel/Cr. St.)	Gran. Backfill	20	9.0	2.0	303, 306, 336
33. DELETED					
34. 4130.05 [150.0 mm (6") Cr. St.]	Erosion Stone	Visual Inspection			

*If the amount of material passing the 1" sieve is 95% or greater the field sample and test sample sizes may be reduced to minimums of 30 lbs. and 5.0 kg. respectively.

** When the amount of material passing the 4.75 mm (#4) sieve is approximately 30% or less, use test method described in I.M. 303 in lieu of the method of I.M. 304.

EXAMPLE OF METHOD FOR SAMPLING FROM CONVEYOR BELT



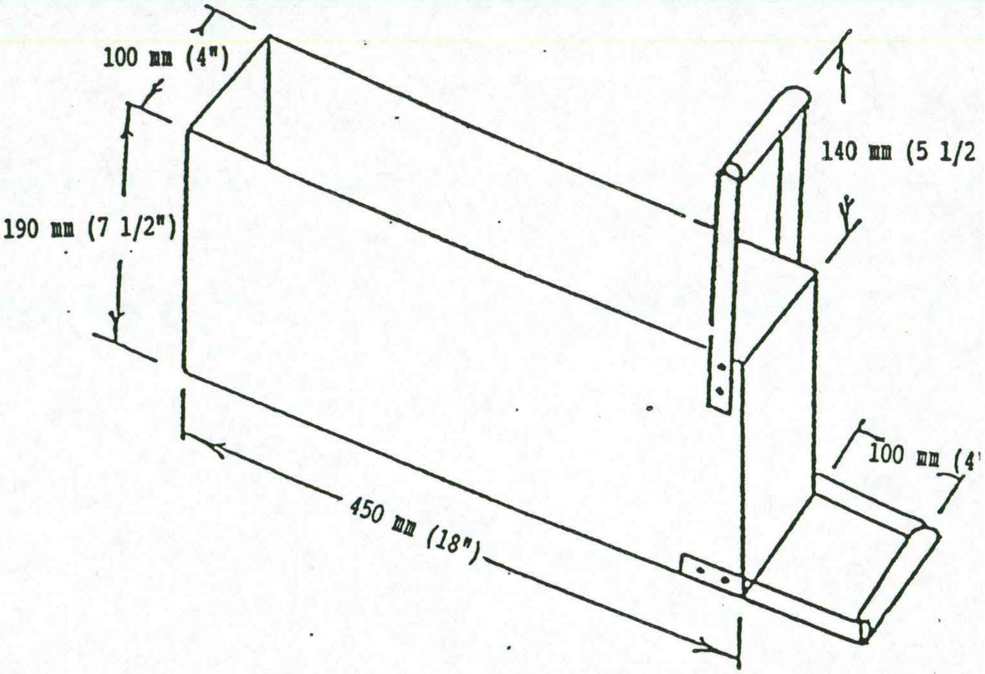
NOTE: EACH OF THE 3 INCREMENTS TO BE TAKEN FROM THE BELT AT SEPARATE TIMES.

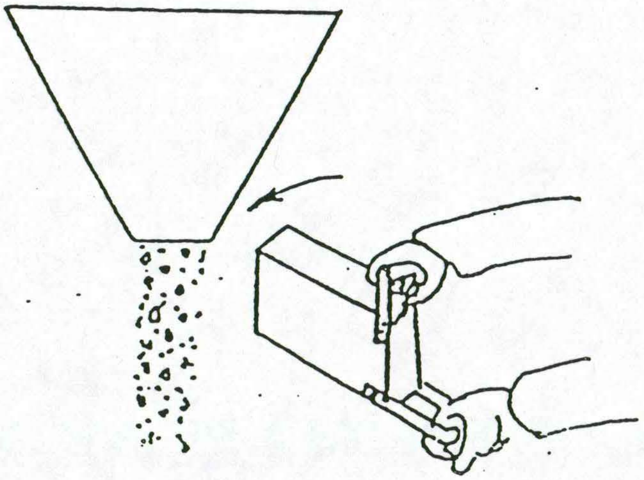
FIGURE 1

ILLUSTRATION OF

SAMPLING DEVICE

WITH HANDLES





NOTE: PASS THE SAMPLING DEVICE QUICKLY THRU THE ENTIRE STREAM FLOW OF AGGREGATE.

FIGURE 2

NOTES

NOTES

NOTES

SECTION III

SAMPLING METHODS AND EQUIPMENT

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.

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

LOS ANGELES ABRASION TEST

Abrasion test using 12 steel balls

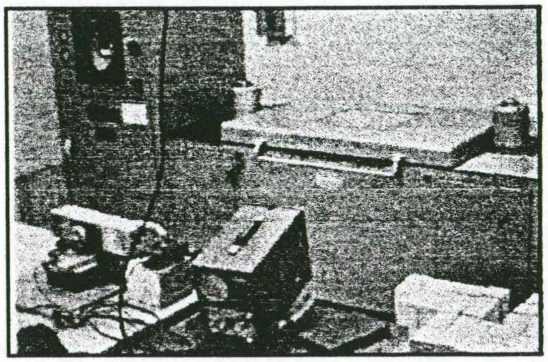
Resistance to abrasion is determined by use of the Los Angeles Abrasion Machine, a cylindrical drum mounted on a horizontal shaft. A specified weight of coarse aggregate is placed in the machine along with a specified number of standard steel balls, the abrasive charge. After rotation at 30-33 rpm for 500 revolutions, the percentage of the aggregate sample which has been abraded to pass a 1.70 mm (#12) sieve is reported as the loss due to abrasion, the percent 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.

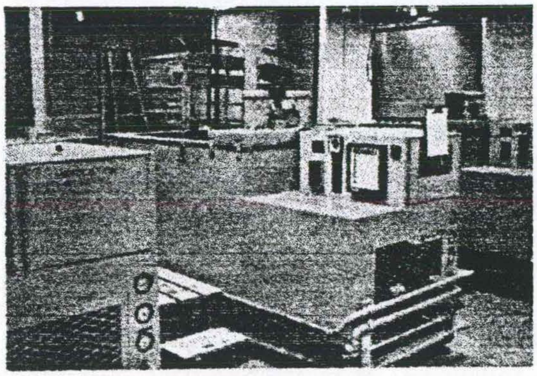
DURABILITY AND SOUNDNESS

These two terms are very similar in meaning and are often used interchangeably. The <u>durability</u> 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 is tested only for coarse aggregate for portland cement concrete. The designations of Class 2, Class 3 and 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 only 20 years, it is Class 3 durability. Class 3i durability aggregates must perform satisfactorily for up to 30 years in interstate class highways. If the coarse aggregate, or a similar aggregate, has not been used in portland cement concrete pavements, we primarily rely on ASTM Designation C666, Method B to make a laboratory determination of durability class. This consists of a series of 300 freeze and thaw test cycles on a concrete specimen.

DURABILITY
CLASS 2
CLASS 3
CLASS 3i



Durability Test - Soundwave machine with prepared samples (concrete cubes with brass plugs on each end). Soundwave is transmitted through each cube before subjecting the sample to 300 F&T cycles. Soundwave is transmitted through each sample after 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 soundwave will indicate how much aggregate was affected.



Freezers for Freeze-Thaw Test

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 cycles 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.

16 cycle

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

25 cycle

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.

NOTES

ABSORPTION AND SURFACE MOISTURE

Absorption and surface moisture may need to be determined (Iowa Test Method 201-A or ASTM Designation C127 & C128), so that the water content can be controlled. An aggregate particle's internal structure is made up of solid matter and voids that may or may not contain water. Terms used to describe the moisture content of aggregate are as follows:

Oven-dry - with no surface or internal moisture.

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

Saturated Surface-dry - an ideal condition in which the aggregate can neither absorb water 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. Portland cement concrete batch weights of material must be adjusted for moisture conditions of the aggregates.

NOTES

SPECIFIC GRAVITY

Specific Gravity is a property which can be determined for all materials. Specific Gravity of a material is used in some calculations and tests for highway construction materials and is an important property for the aggregate inspector to understand. It is not a measure of aggregate quality.

Simply defined, specific gravity is the number of times heavier a material is than water. Stated another way, it is the ratio of the weight of a material to the weight of an equal volume of water. Even another way of stating the definition would be to say that specific gravity is the relative density of a material to water. If it were not for tradition, perhaps the term "relative density" would be more applicable than "specific gravity" as gravity has little to do with the matter except to provide the force which contributes to weight.

Test methods for determining specific gravity for fine and coarse aggregates are described in ASTM C128 and C127 or Iowa Test Method 201-A. In portland cement concrete calculations, the specific gravities of saturated-surface-dry aggregates are ordinarily used, that is, all the pores in each aggregate particle should be filled with moisture, but there should be no excess moisture on the particular surface at time of test.

NOTES

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 P.C. concrete mix.

UNIT WEIGHT

Unit weight is a ratio of weight to volume, such as kilograms per cubic meter. Unit weight is not a measure of quality, but is useful in converting weights of material to volumes. See ASTM Designation: C29.

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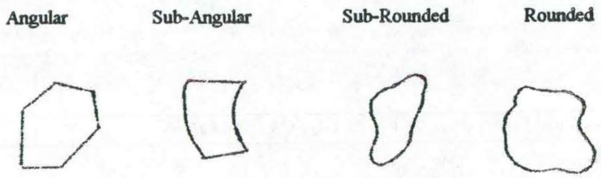
SHAPE AND SURFACE TEXTURE

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



Aggregate particles should ideally be equa-dimensional and free of excessive amounts of flat and elongated pieces. Long, silvery 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 more workable without a detrimental effect on the hardened concrete.

The texture of aggregate particles are normally defined in the following sequence: lithographic, sublithographic, 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 a 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.

***GRADATION** - Describes the various sizes of aggregate particles in terms of percentage passing or a percentage retained on a set of standardized square sieves.*

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

NOTES

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. See Figure 2 for comparison of dense and gap or open gradations of aggregates.

Plasticity Index: The plasticity index of an aggregate is determined in order to determine the presence and relative activity of contained clay minerals. In Iowa, the Atterberg test (Iowa Test Method 109-A) is used to determine the Plasticity Index (P.I.) of a soil. The P.I. is directly related to the amount of clay in a material and is determined by subtracting the plastic limit from the liquid limit.

The Liquid Limit (L.L.) Is that water content, expressed in percent dry weight, at which the material passes from a plastic to a liquid state. In general, it is determined by adding water to a portion of the minus 425 mm (#40) sieve size material until a certain consistency is reached.

NOTES

After at least 15 minutes of aging in a humidity chamber, a small amount is transferred to a special pan on top of a L.L. machine. A groove is made through the middle of the sample on the pan, separating the two halves by a fraction of an inch. The number of "drops" needed to bring a portion of the two halves back together is used to determine if the proper amount of water was initially added. If the initial amount of water was wrong, the sample is remixed and rerun. The final sample is then weighed, dried, and again weighed to determine the amount of water added, as well as the weight of the original grooved samples.

The Plastic Limit (P.L.) is that water content, expressed in percent dry weight, at which the material passes from a semi-solid state to a plastic state. Generally, it is determined by adding water to a portion of the minus 425 mm (#40) sieve size material and then rolling it between the palm of the hand and a clean dry table. If the "threads" reach 3.175 mm (1/8 in.) diameter without breaking, they are remade into balls and rolled again. When the

NOTES

balls cannot be made to reach the 3.175 mm (1/8 in.) diameter thread size without breaking, they are placed in a pan for weighing, drying and reweighing to determine the weight of water, as well as the weight of the "threads."

SUMMARY - (Aggregates)

For 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. Aggregates containing natural shale or shaly 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.

AGGREGATE SPEC. S (94) JAN

MATERIAL - SPEC.	F&T C	F&T A	ABRASION	ABSPTION	P.I.	COAL/ SHALE	MUD/ CLAY	CHERT	COMMENTS
Conc. Sand - 4110						2			1.5 Mortar Strength
Conc. Stone - 4115		6	50			0.5	0.5	*	*2-Strc, 3-non Strc
Overlay - 4115.08		4	40	2.5		*	*	*/0.5	*Total of 1%
CL. "C" Gravel - 4120	15					*10	*15		*Total of 20
CL. "A" Crushed - 4120	15*		45*				4		*Shoulders only 55 Abrasion if 10 A-Freeze Max.
CL. A Gran. Shldr - 4120	15		45				4		
CL. "B" - 4120	20*		55*				4		*Total of 65%
CL. "D" - 4120	CONTRACT								
Gran. Subbase - 4121		25	45		5*				*Each Indv. Source
Macadam - 4122	10		45						
Soil Agg. Subbgr - 4123	15				**				**4-Gravel, 6-Cr. Stone
Cover Aggr. - 4125	10		40			(X)			(X)-2 on #16,.5 on #4
Slurry Aggr. - 4125		10	40						
"B" A.C. Stone - 4126	*	*	45	6	4**	5			*Primary 10 "C" & 25 "A" *Other 10 "C" & 45 "A" ** Composite
"A" A.C. Coarse - 4127		10	45	6			0.5		
"A" A.C. Fine - 4127						2	*0	*0	*1.5 Screen
Revetment - 4130		10	50						Primary Cl. - A &B
Revetment - 4130	5		50						Non-Primary - CL. A & B
Revetment - 4130	10		50						All Proj. - CL. D
Revetment - 4130		10	50						All Proj. - CL. E
Erosion Stone - 4130	15		50				5		
Porous Backfill - 4131		10	45			5			
Spec. Backfill - 4132					10				Gravel
Spec. Backfill - 4132									Crushed Concrete
Spec. Backfill - 4132									Crushed Stone
Gran. Backfill - 4133	15		45						

NOTES

SECTION IV
SIEVE ANALYSIS

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 section under the subsection “Aggregate.”

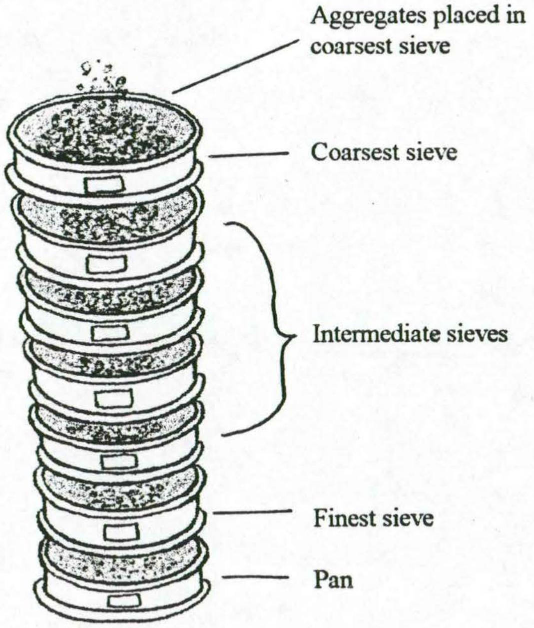
Sieve analysis is nothing more than the separation of a material based on particle size. For example, material which passes a 38.1 mm (11/2 in.) sieve and is retained on a 25.4 mm (1 in.) sieve would not contain any particle larger than 38.1mm (11/2 in.) nor smaller than 25.4 mm (1 in.). Sieves are normally arranged in a “nest” with the largest wire openings at the top of the nest and the smallest at the bottom.

COARSE AGGREGATE SIEVES

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

FINE AGGGREGATE SIEVES

SI UNITS	US UNITS
4.75 mm.	No. 4 (0.187 in.)
2.36 mm.	N0. 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.)
O.150 mm.	No.100 (0.0059 in.)



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.

$$\textit{Percent retained} = \frac{\textit{Weight retained}}{\textit{Original dry weight}} \times 100$$

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.

METHOD OF TEST
SIEVE ANALYSIS OF FINE AGGREGATE
Field Procedures for Test Method Iowa No. 205

SCOPE

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

PROCEDURE

A. Apparatus

1. Balance accurate to within 0.1 percent of mass (weight) of the sample to be tested.

2. Sieves - 203 mm or 305 mm (8" or 12") diameter sieves of suitable sizes to furnish the information required by the specifications covering the material to be tested. This will normally be a nest of sieves consisting of 4.75 mm (Nos. 4,) 2.36 mm (8), 1.18 mm (16), 600 μm (30), 300 μm (50), 150 μm (100), 75 μm (200) and pan. The woven wire cloth sieves must conform to AASHTO Designation M-92.

3. Mechanical sieve shaker.

4. Oven or drying stove.

5. Wash pan of sufficient size to prevent loss of water and material.

6. Fiber bristle sieve cleaning brush (similar to stencil brush or cropped paint brush).

B. Test Sample

1. Obtain the sample for sieve analysis from the material to be tested by one of the following methods:

   (a) Use of a sample splitter.

   (b) Method of quartering after being thoroughly mixed and in a damp condition.

   (c) Place the field sample on a hard, clean, level, nonabsorbent surface. If the material is not damp add water to it. Thoroughly mix the sample and form a miniature stockpile. Obtain a test sample by selecting at least five increments of material at random locations from the miniature stockpile, using a small scoop or spoon.

2. The sample for test should be approximately of the mass (weight) desired and must be the end result of the sampling method. Do not attempt to select sample of an exact predetermined mass (weight).

3. Samples of fine aggregate for sieve analysis shall conform to the sample size for the applicable material as indicated by Matls. I.M. 301.

C. Balance
1. Balance should be tared each time it is used.

D. Preparation of Sample
1. First subject the sample to the "Method of Test for Determining the Amount of Material Finer Than the 75 μm (No. 200) Sieve in Aggregate by Washing" Matls. I.M. 306.

E. Test Procedure
1. Place the washed and dried sample on the nested sieves, then place the nest in the Mechanical Sieve Shaker. Secure the sieves in the shaker and begin the sieving operation. Generally it will require at least 10 minutes to sieve a fine aggregate sample to completion. In no case should particles of the sample be turned or manipulated through the sieves by hand. If the Mechanical Sieve Shaker's action is such that the sample is not sieved to completion in a reasonable time, the cause could be overloading of the sieves. A guide for determining an overloaded sieve is; The retained fractions should weigh less than 4 grams per 645 mm^2 of sieve surface. For a 203.2 mm (8 in.) diameter sieve this amount would be 200 grams. Continue sieving until not more than 0.5 by mass (weight) of the dry mass (weight) of the washed sample passes any sieve during one minute. If the overloading condition cannot be corrected by adjusting the sample size on future tests, the washed and dried sample should be divided for sieving and then recombined for weighing.

2. Clean the retained material out of the sieves for weighing, so that a minimum of material is retained in the sieve by clinging to the mesh. Particles may be removed most readily from a sieve by inverting the sieve over a pan and tapping the sieve by hand and/or pushing (without force) the particles out of the mesh into the pan. Care should be exercised in cleaning the sieves to not damage the wire mesh by bending or breaking the wires. A brush should be used for cleaning the 1.18 mm (No. 16), 600 μm (30), and 300 μm (50) sieves. Do not use a brush

or any external force to attempt to clean the 150 μm(No. 100) or 75 μm(No. 200) sieve. Gentle tapping of the sieve frame is recommended for these sieves. If clogging of the mesh occurs on these finer sieves, they should be returned to the central laboratory for cleaning.

3. Weigh the fraction of material retained on each sieve and in the pan and record. The combined mass (weight) of material retained on all the sieves and in the pan must equal the original mass (weight) after washing within 0.5 percent.
   The original dry mass (weight) of the sample must also be within 0.5 percent of the mass (weight) on each sieve and in the pan plus the washing loss. If the difference exceeds 0.5 percent check for a subtraction error in the washing loss.

4. The total amount of material finer than the No. 200 sieve is determined by adding the mass (weight) of material passing the No. 200 sieve by dry sieving to that lost by washing.

F. Calculations

1. Divide the mass (weight) of the material retained on each sieve (and in the Pan) by the total original dry mass (weight) of the sample, including all the minus No. 200 material, to determine the percentage retained on each sieve.

2. In computing the percentage retained and consequent percentage passing each sieve, the computations are carried out to the nearest 0.1 percent so that the percentages retained will add to a total of 100 percent. In reporting the sieve analysis, however, these results are shown only to two significant figures--i.e., to the nearest percent for percentages of 10.0 and larger and to the nearest tenth of a percent for lower results.

3. Because the mass (weight) of material retained on the sieves may not equal the dry mass (weight) after washing, the total of the percentages retained may not be exactly 100.0%. If this occurs, the percentages should be altered by prorating the percentages so that they do total 100.0% (see example).

Fine Aggregate Sieve Analysis Example:

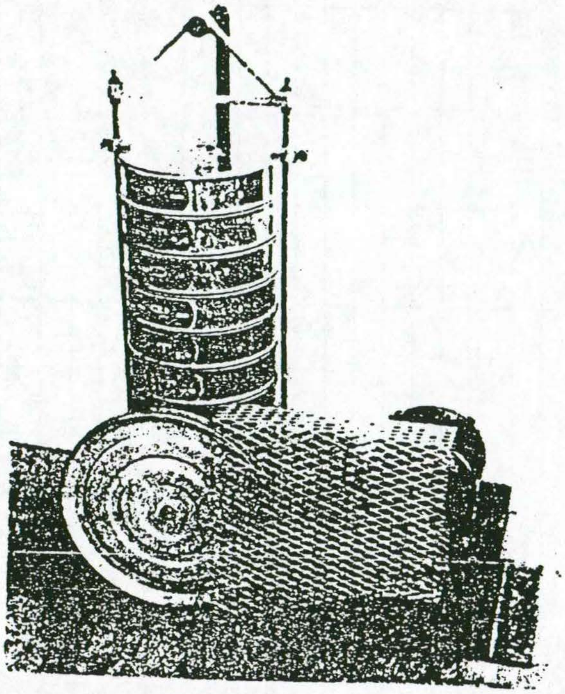
Original Dry Mass (Weight) of Sample = 594.0
Dry Sample Mass (Weight) After Washing = 591.5

Sieve Size	Mass (Weight) Retained (g)
9.50 mm (3/8)	0.0
4.75 mm (4)	29.0
2.36 mm (8)	64.5
1.18 mm (16)	102.0
600 µm (30)	181.5
300 µm (50)	154.5
150 µm (100)	51.0
75 µm (200)	6.0
Pan	1.0
Total	589.5

589.5 : 591.5 = 99.7%

Therefore this mass (weight) loss from sieving is within the 0.5% tolerance.

Sieve No.	%Retained	(Prorated)	Passing	(Reportable)
9.5 mm (3/8)	0.0 ÷ 594.0 = 0	0.0	100	100
4.75 mm (4)	29.0 ÷ 594.0 = 4.9	4.9	95.1	95
2.36 mm (8)	64.5 ÷ 594.0 = 10.9	10.9	84.2	84
1.18 mm (16)	102.0 ÷ 594.0 = 17.2	17.2	67.0	67
600 µm (30)	181.5 ÷ 594.0 = 30.6	30.7	36.3	36
300 µm (50)	154.5 ÷ 594.0 = 26.0	26.1	10.2	10
150 µm (100)	51.0 ÷ 594.0 = 8.6	8.6	1.6	1.6
75 µm (200)	6.0 ÷ 594.0 = 1.0	1.0	0.6	0.6
Pan & Wash	3.5 ÷ 594.0 = 0.6	0.6		
	99.8	100.0		



Mechanical Sieve Shaker and Sieves

Form 820180
10-95

FINE AGGREGATE

Iowa Department of Transportation
SIEVE ANALYSIS WORKSHEET

Lab. No.		Material		Material		Material
Co. & Proj.						
Producer						
Contractor						
Sampled by		Date		Date		Date
Sample Loc.						

	Coarse Sample					Coarse Sample					Coarse Sample				
	Split Diff.	Orig. Dry Mass (Weight)				Split Diff.	Orig. Dry Mass (Weight)				Split Diff.	Orig. Dry Mass (Weight)			
	Tol. Check	Dry Mass (Wt.) Washed Sample				Tol. Check	Dry Mass (Wt.) Washed Sample				Tol. Check	Dry Mass (Wt.) Washed Sample			
Sieve Size	Mass (Wt.) Retd.	% Retd.	% Retd. X-----	% Psg. Final	**Specs.**	Mass (Wt.) Retd.	% Retd.	% Retd. X-----	% Psg. Final	**Specs.**	Mass (Wt.) Retd.	% Retd.	% Retd. X-----	% Psg. Final	**Specs.**
37.5mm (1½)															
26.5mm (1.06)															
19mm (¾)															
13.2mm (0.530)															
9.5mm (⅜)															
4.75mm (4)															
2.36mm (8)															
Total 4.75mm (4)															
Pan															
Total															

	Fine Sample					Fine Sample					Fine Sample				
		Orig. Dry Mass (Weight)		594.0			Orig. Dry Mass (Weight)					Orig. Dry Mass (Weight)			
	Tol. Check 99.7%	Dry Mass (Wt.) Washed Sample		591.5		Tol. Check	Dry Mass (Wt.) Washed Sample				Tol. Check	Dry Mass (Wt.) Washed Sample			
		Washing Loss		2.5			Washing Loss					Washing Loss			
Sieve Size	Mass (Wt.) Retd.	% Retd.		% Passing	**Specs.**	Mass (Wt.) Retd.	% Retd.		% Passing	**Specs.**	Mass (Wt.) Retd.	% Retd.		% Passing	**Specs.**
			Final					Final					Final		
9.5mm (⅜)	0.0	0.0		100.0	100										
4.75mm (4)	29.0	4.9		95.1	95-100										
2.36mm (8)	64.5	10.9		84.2	75-100										
1.18mm (16)	102.0	17.2		67.0											
600µm (30)	181.5	30.07		36.3											
300µm (50)	154.5	26.01		10.2											
150µm (100)	51.0	8.6		1.6											
75µm (200)	6.0	1.0		0.6	0-1.5										
Wash	2.5														
Pan	1.0	0.6													
Total	592.0	99.8	100.0												
Less +4.75mm (4)															
Passing #4.75mm (4)															

Date Reptd.		Date Reptd.		Date Reptd.	
Tested by	Date	Tested by	Date	Tested by	Date

NOTES

NOTES

METHOD OF TEST
SIEVE ANALYSIS OF COARSE AGGREGATES*
Field Procedures for Lab. Test Method 204

SCOPE

This method of test covers a procedure for the determination of the particle size distribution of coarse aggregates, using sieves with square openings.

PROCEDURE

A. Apparatus

1. Balance accurate to within 0.1 percent of the mass (weight) of the sample to be tested.

2. Sieves - Sieves with square openings mounted on substantial frames that are constructed in such a manner that will prevent loss of material during sieving. Use suitable sieve sizes to furnish the information required by the specifications covering the material to be tested. The woven wire cloth shall conform to AASHTO M-92. This will normally be a set of sieves consisting of: 37.5 mm (1 1/2 in.), 26.5 mm (1.06 in.), 19 mm (3/4 in.), 13.2 mm (0.530 in.), 9.5 mm (3/8 in.), 4.75 mm (#4), and 2.36 mm (#8).

3. Mechanical or hand-powered sieve shaker.

4. Drying oven or stove.

5. Wash pan of sufficient size to prevent loss of water and material.

B. Sample Size

1. Reduce the sample by quartering or splitting as described in I.M. 336 to the size that will conform with the applicable material as shown in I.M. 301.

C. Sample Preparation

1. Aggregates that have changes in moisture for different particle sizes must be dried to a constant mass (weight).

2. Aggregates that the absorbed moisture stays essentially constant for the different particle sizes may be sieved at a surface-dry condition (no free water present).

*This procedure is used for gradation, numbers 12, 22, 24, 25, 26, and 30, and is applicable when the amount of material passing the 4.75 mm (No. 4) sieve is approximately 30% or less. All of the fine aggregate sieves shall be used [4.75 mm (No. 4), 2.36 mm (No. 8), 1.18 mm (No. 16), 600 μm (No. 30), 300 μm (No. 50), 150 μm (No. 100), and 75 μm (No. 200)].

D. Balance

1. Balance should be tared each time it is used.

E. Test Procedure

1. Sieve the sample over the required sieves. The sieving operation must be conducted by means of a lateral and vertical motion of the sieve, accompanied by a jarring action so as to keep the sample moving continuously over the surface of the sieve. Do not attempt to turn or manipulate the sample through the sieve by hand. Continue sieving until not more than 0.5 percent by mass (weight) of the total sample passes any sieve during one minute of sieving. On that portion of the sample retained on the 4.75 mm (No. 4) sieve, the above described procedure for determining thoroughness of sieving is to be carried out with a single layer of material. When mechanical sieving is used the thoroughness of sieving is to be tested by using the hand method described above.

   Note: Normally the sieves that are required for this analysis are the 2.36 mm (No. 8) size and above. When specifications require a determination on a sieve finer than the 2.36 mm (No. 8) size, the material passing the 2.36 mm (No. 8) sieve is sieved through the appropriate size sieve or sieves.

2. If sieving to completion as described above is not accomplished, reduce the amount of material carried on the sieve and/or sieves for a longer period of time. If overloading a sieve is anticipated when using a mechanical sieve shaker, divide the sample for sieving and recombine it for weighing.

3. Determine and record the mass (weight) of material retained on each sieve and in the pan. The combined mass (weight) of material retained on all of the sieves and in the pan must equal the mass (weight) before sieving within 0.5 percent.

4. Divide the mass (weight) of the material retained on each sieve and in the pan by the total original mass (weight) of the sample to determine the percentage retained on each sieve. These percentages retained should total 100.0. If the total is not exactly 100.0, the percentages should be altered by prorating the difference so that they do total 100.0.

Note: In some instances (e.g. granular surfacing material, Class A & D crushed stone, etc.) particles are coated to the extent that dry sieving will not accurately reflect the true gradation of the material. In these instances, the sample must be washed over the smallest sieve for which there is a specification requirement. The total percentage passing this sieve is a combination of the washing loss and the amount passing the sieve obtained by dry sieving the washed sample.

5. When it is necessary to determine the amount of material finer than the 75 μm (No. 200) sieve, select the test and sample by one of the following methods:

   (a) Splitting
      (1) The sample to be tested may be selected by splitting as described in Matls. I.M. 336.
      (2) If a sample splitter is used in reducing the field sample (Par. B), continue splitting the remaining portion until the test sample for washing will be of the size required in Matls. I.M. 306.

   (b) Entire sample
      (1) The sample obtained for determining the sieve analysis may also be used for the determination of the material finer than the minus 75 μm (No. 200) sieve by washing. This test is performed prior to the sieve analysis.

   (c) Testing
      (1) Subject the sample to the "Method of Test For Determining the Amount of Material Finer Than the 75 μm (No. 200) Sieve in Aggregate by Washing," Matls. I.M. 306.

(2) Only the total material finer than the 75 μm (No. 200) sieve is required from the wash sample. The Matls. I.M. 306 procedure provides only the portion that is lost in washing the sample. To this must be added the amount of minus 75 μm (No. 200) material obtained when dry sieving.

Therefore, upon completion of the procedure outlined in Matls. I.M. 305, sieve the washed and dried sample over a 4.75 mm (No. 4) or 2.36 mm (No. 8) sieve and discard the retained material. Place the portion of material passing the 4.75 mm (No. 4) or 2.36 mm (No. 8) sieve on a nest of sieves including 1.18 mm (No. 16), 600 μm (No. 30), 75 μm (No. 200) and pan, [the No. 1.18 mm (No. 16) and 600 μm (No. 30) sieves are included to protect the No. 75 μm (No. 200) sieve] and after a minimum time of 5 minutes on a mechanical shaker, determine only the mass (weight) of the material in the pan.

(3) Add the washing loss [minus 75 μm (No. 200)] to the dry sieving loss [minus 75 μm (No. 200)] to obtain the total minus 75 μm (No. 200). Divide this total by the dry mass (weight) of the sample (before washing) and record as percent passing the 75 μm (No. 200).

*The entire procedure in D-5 may be omitted provided the total amount of material finer than the 75 μm (No. 200) is not a specification requirement.

F. Calculations

1. In computing the percentages retained and the subsequent percentages passing each sieve, the computations are carried out to the nearest 0.1 percent so that the percentages retained will add to a total of 100.0 percent. In reporting the sieve analysis, however, these results are shown to only two significant figures, i.e., to the nearest percent for percentages above 10 and to the nearest tenth of a percent for lower results.

Coarse Aggregate Sieve Analysis
Example

Coarse Aggregate for Class C3 Concrete Mix. Minimum Sample Size Required (I.M. 301) = 10,000 g. Original Surface Dry Mass (Weight) of Sample = 11,548 g.

Sieve No.	Surface Dry Mass (Weight) Retained - Grams
37.5 mm(1.50")	0
26.5 mm(1.06")	1154
19.0 mm (3/4")	2136
13.2 mm (0.530")	2892
9.5 mm (3/8")	2766
4.75 mm (No. 4)	2164
2.36 mm (No. 8)	242
Pan	185
	Total 11,539

11,539 ÷ 11,548 = 99.9%

Therefore the mass loss from sieving is within the 0.5% tolerance.

Sieve Size			%Retained Prorated	%Psq.
37.5 mm (1.50")	(0÷11,548) X 100	= 0.0	0.0	100.0
26.5 mm (1.06")	(1154÷11,548) X 100	= 10.0	10.0	90.0
19 mm (3/4")	(2136÷11,548) X 100	= 18.5	18.5	71.5
13.2 mm (0.530)	(2892÷11,548) X 100	= 25.0	25.1	46.4
9.5 mm (3/8")	(2766÷11,548) X 100	= 24.0	24.0	22.4
4.75 mm (No. 4)	(2164÷11,548) X 100	= 18.7	18.7	3.7
2.36 mm (No. 8)	(242 ÷11,548) X 100	= 2.1	2.1	1.6
Pan	(185 ÷11,548) X 100	= 1.6	1.6	
		99.9	100.0	

11,539 ÷ 11,548 = 99.9%

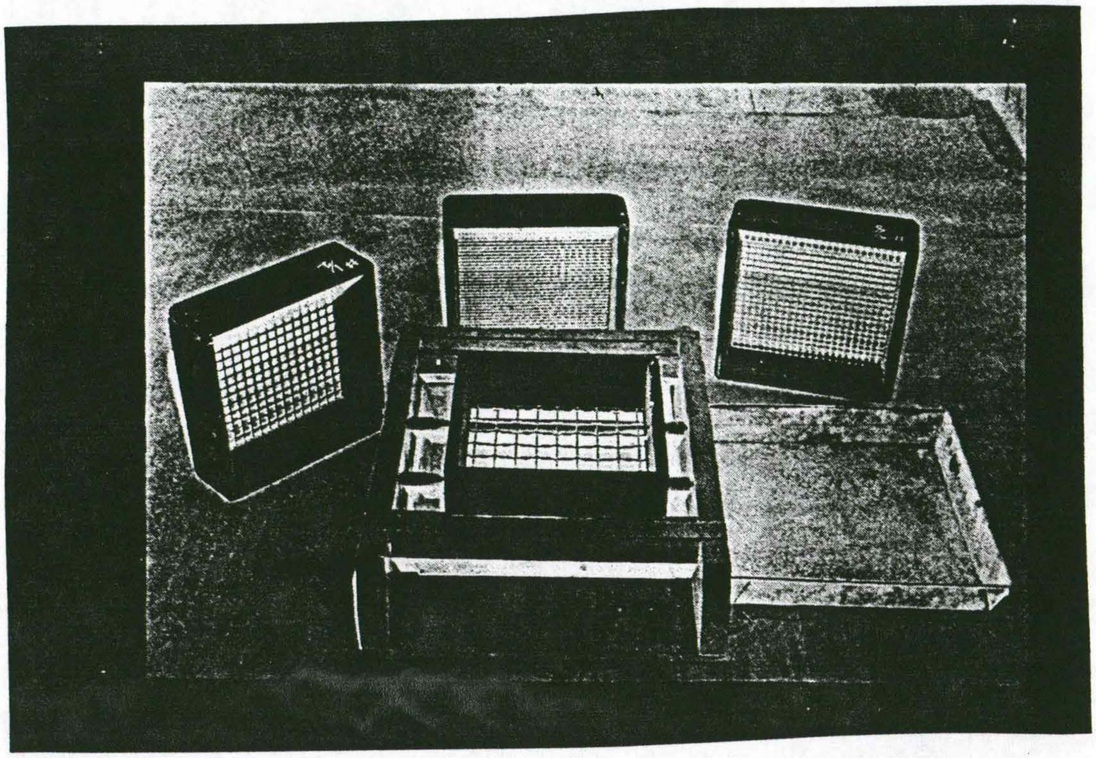
Therefore the mass loss from sieving is within the 0.5% tolerance.

Dry Mass (Weight) of Wash Sample =2571 g.
Dry Mass (Weight) of Washed Sample =2555 g.
Washing Loss [Minus 75 μm (No. 200)] = 16 g.
Dry Sieving Loss [Minus 75 μm (No. 200)] = 4 g.

Total Minus No. 200 = $\frac{20}{2571}$ x 100 = 0.8%

Sieve Analysis

Sieve	% Passing
37.5 mm (1.50")	100
26.5 mm (1.06")	90
19 mm (3/4")	72
13.2 mm (0.530")	46
9.5 mm (3/8")	22
4.75 mm (No. 4)	3.7
2.36 mm (No. 8)	1.6
75 μm (No.200)	0.8



BOX SCREENS

Form 820180
10-95

Iowa Department of Transportation
SIEVE ANALYSIS WORKSHEET

Lab. No.		Material			Material			Material
Co. & Proj.								
Producer								
Contractor								
Sampled by		Date			Date			Date
Sample Loc.								

Coarse Sample

	Split Diff.	Orig. Dry Mass (Weight)		11548		Split Diff.	Orig. Dry Mass (Weight)				Split Diff.	Orig. Dry Mass (Weight)			
	Tol. Check 99.9%	Dry Mass (Wt.) Washed Sample				Tol. Check	Dry Mass (Wt.) Washed Sample				Tol. Check	Dry Mass (Wt.) Washed Sample			
Sieve Size	Mass (Wt.) Retd.	% Retd.	% Retd. X-----	% Psg. Final	**Specs.**	Mass (Wt.) Retd.	% Retd.	% Retd. X-----	% Psg. Final	**Specs.**	Mass (Wt.) Retd.	% Retd.	% Retd. X-----	% Psg. Final	**Specs.**
37.5mm (1½)	0	0.0		100.0											
26.5mm (1.06)	1154	10.0		90.0											
19mm (¾)	2136	18.5		71.5											
13.2mm (0.530)	2892	25.~~0~~1		46.4											
9.5mm (⅜)	2766	24.0		22.4											
4.75mm (4)	2164	18.7		3.7											
2.36mm (8)	242	2.1		1.6											
Total 4.75mm (4)															
Pan	185	1.6													
Total	11539	100.0													

Fine Sample

		Orig. Dry Mass (Weight)		2571			Orig. Dry Mass (Weight)					Orig. Dry Mass (Weight)			
	Tol. Check	Dry Mass (Wt.) Washed Sample		2555		Tol. Check	Dry Mass (Wt.) Washed Sample				Tol. Check	Dry Mass (Wt.) Washed Sample			
		Washing Loss		16			Washing Loss					Washing Loss			
Sieve Size	Mass (Wt.) Retd.	% Retd.		% Passing	**Specs.**	Mass (Wt.) Retd.	% Retd.		% Passing	**Specs.**	Mass (Wt.) Retd.	% Retd.		% Passing	**Specs.**
			Final					Final					Final		
9.5mm (⅜)															
4.75mm (4)															
2.36mm (8)															
1.18mm (16)															
600µm (30)															
300µm (50)															
150µm (100)															
75µm (200)				0.8											
Wash	16														
Pan	4														
Total															
Less +4.75mm (4)															
Passing #4.75mm (4)															

Date Reptd.		Date Reptd.		Date Reptd.	
Tested by	Date	Tested by	Date	Tested by	Date

DRAFT
METHOD OF TEST
SIEVE ANALYSIS OF CRUSHED COMPOSITE PAVEMENT MATERIALS FOR FIELD TESTING

SCOPE

This method of test covers a procedure for the determination of the particle size distribution of unwashed coarse material, using sieves with square openings.

PROCEDURE

A. Apparatus

1. Balance accurate to within 0.1 percent of the mass (weight) of the sample to be tested.

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

3. Mechanical or hand-powered sieve shaker.

4. Mechanical fan to aid in air drying material (optional).

5. Drying pan of sufficient size to prevent loss of material.

B. Sample Size

1. Reduce the sample by quartering or splitting as described in I.M. 336 to the size that will conform with the applicable material as shown in I.M. 301.

C. Sample Preparation

1. Material from crushed composite pavements shall be sieved at a surface-dry condition determined by visual examination.
Note: This procedure is used for testing crushed composite AC/PC pavement for gradation numbers 11 and 30 only. No artificial heat shall be used to air dry material.

D. Test Procedure

1. Sieve the sample over the sieves with openings of 2.36 mm (No. 8) size or greater. No gradation determination will be made for material finer than the 2.36 mm (No. 8) sieve. The sieving operation must be conducted by means of a lateral and vertical motion of the sieve, accompanied by a jarring action so as to keep the sample moving continuously over the surface of the sieve. Do not attempt to turn or manipulate the sample through the sieve by hand. Continue sieving until not more than 0.5 percent by mass (weight) of the total sample passes any sieve during one minute of sieving. On that portion of the sample retained on the 4.75 mm (No. 4) sieve, the above described procedure for determining thoroughness of sieving is to be carried out with a single layer of material. When mechanical sieving is used, the thoroughness of sieving is to be tested by using the hand method described above.

2. If sieving to completion as described above is not accomplished, reduce the amount of material carried on the sieve and/or sieves for a longer period of time. If overloading a sieve is anticipated when using a mechanical sieve shaker, divide the sample for sieving and recombine it for weighing.

3. Determine and record the mass (weight) of material retained on each sieve and in the pan. The combined mass (weight) of material retained on all of the sieves and in the pan must equal the mass (weight) before sieving within 0.5 percent.

4. Divide the mass (weight) of the material retained on each sieve and in the pan by the total original mass (weight) of the sample to determine the percentage retained on each sieve. These percentages retained should total 100.0. If the total is not exactly 100.0, the percentages should be altered by prorating the difference so that they do total 100.0.

   Note: In some instances particles are coated to the extent that dry sieving will not accurately reflect the true gradation of the material. In these instances, the sample must be washed over the smallest sieve for which there is a specification requirement. The total percentage passing this sieve is a combination of the washing loss and the amount passing the sieve obtained by dry sieving the washed sample.

E. Calculations

1. In computing the percentages retained and the subsequent percentages passing each sieve, the computations are carried out to the nearest 0.1 percent so that the percentages retained will add to a total of 100.0 percent. In reporting the sieve analysis, however, these results are shown to only two significant figures, i.e.,

to the nearest percent for percentages above 10 and to the nearest tenth of a percent for lower results.

2. Rounding-off: When rounding off a number, always round five (5) or greater up and four (4) or less down. Examples are as follows:

Calculated Value	Rounded-Off Value
10.4%	10%
10.5%	11%
10.6%	11%
11.4%	11%
11.5%	12%
11.6%	12%
6.45%	6.5%
6.55%	6.6%
6.65%	6.7%

Coarse Material Sieve Analysis
Example

Coarse material for crushed composite pavement. Minimum Sample Size Required (I.M. 301) = 2,500 g. Original Surface Dry Mass (Weight) of Sample = 2,560 g.

Sieve No.	Surface Dry Mass (Weight) Retained - Grams
26.5 mm (1.06 in.)	0
19.0 mm (3/4 in.)	25.6
13.2 mm (0.530 in.)	335.5
9.5 mm (3/8 in.)	384.1
4.75 mm (No. 4)	645.4
2.36 mm (No. 8)	411.8
Pan	758.0
Total	2560.4

2560.4 ÷ 2561 x 100 = 100%

Therefore the mass loss from sieving is within the 0.5% tolerance.

Form 820180
10-92

Iowa Department of Transportation

SIEVE ANALYSIS WORKSHEET

Lab. No.	Crushed Material Composite AC/PC Pavement	Material	Material
Co. & Proj.			
Producer	Gradation II (modified)		
Contractor			
Sampled by	Date	Date	Date
Sample Loc.			

Coarse Sample

Orig. Dry Weight	2561.0	Orig. Dry Weight	Orig. Dry Weight
Dry Wt. Washed Sample		Dry Wt. Washed Sample	Dry Wt. Washed Sample

Sieve Size	Wt. Retd.	% Retd.	% Retd. X-----	% Psg. Final	Specs.	Wt. Retd.	% Retd.	% Retd. X-----	% Psg. Final	Specs.	Wt. Retd.	% Retd.	% Retd. X-----	% Psg. Final	Specs.
37.5mm (1½)	0.0														
26.5mm (1.06)	0.0														
19mm (¾)	25.6	1.0	99.0	99	97-100										
13.2mm (0.530)	335.5	13.1	85.0	86											
9.5mm (⅜)	384.1	15.0	70.9	71											
4.75mm (4)	645.4	25.2	45.7	46	30-75										
2.36mm (8)	411.8	16.1	29.6	30	15-45										
Total 4.75mm (4)															
Pan	758.0	29.6													
Total	2560.4	100.0													

Fine Sample

Orig. Dry Weight	Orig. Dry Weight	Orig. Dry Weight
Dry Wt. Washed Sample	Dry Wt. Washed Sample	Dry Wt. Washed Sample
Washing Loss	Washing Loss	Washing Loss

Sieve Size	Wt. Retd.	% Retd.		% Passing	Specs.	Wt. Retd.	% Retd.		% Passing	Specs.	Wt. Retd.	% Retd.		% Passing	Specs.
			Final					Final					Final		
9.5mm (⅜)															
4.75mm (4)															
2.36mm (8)															
1.18mm (16)															
600µm (30)															
300µm (50)															
150µm (100)															
75µm (200)															
Wash															
Pan															
Total															
Less +4.75mm (4)															
Passing #4.75mm (4)															

Date Reptd.		Date Reptd.		Date Reptd.	
Tested by	Date	Tested by	Date	Tested by	Date

METHOD OF TEST
SIEVE ANALYSIS OF COMBINED AGGREGATES

SCOPE

This method of test covers a procedure for the determination of the particle size distribution of combined coarse and fine aggregates, using sieves with square openings.

PROCEDURE

A. Apparatus

1. Balance accurate to within 0.1 percent of the mass (weight) of the sample to be tested.

2. Sieves - The sieves with square openings shall be mounted on substantial frames such as wood or brass constructed in a manner that will prevent loss of material during sieving. Suitable sieve sizes shall be selected to furnish the information required by the specifications, covering the material to be tested. The woven wire cloth sieves shall conform to AASHTO M-92.

3. Oven or drying stove.

4. Mechanical sieve shaker.

5. Tub for washing sample.

6. Fiber bristle sieve cleaning brush (similar to a stencil brush or cropped paint brush).

B. Sample Size

1. Follow method I.M. 336 and select a coarse sample in accordance with Matls. I.M. 301 for the material to be tested.

2. From the remaining portion of the field sample, follow I.M. 336 and select a fine sample of sufficient size to ensure that it will contain a minimum of 500 grams of dry material passing the 4.75 mm (No. 4) screen.

3. To estimate the minimum sample size needed for 'fine sample', divide 500 grams by the estimated percent passing the 4.75 mm (No. 4) screen and multiply by 100.

$$\frac{500}{\text{est. \% psg. 4.75 mm (No.4)}} \times 100$$

4. Splitting - Compare the percent retained on the 4.75 mm (No. 4) screen of the coarse test fraction with the percent retained on the 4.75 mm (No. 4) of the fine test fraction. If a difference of more than 3 percent is found, the operator shall re-test the material. This is achieved by comparing the percent retained on the 4.75 mm (No.4) screen of the fine sample with the percent retained on the 4.75 mm (No.4) screen of the coarse sample.

C. Balance

1. Balance should be tared each time it is used.

D. Test Procedure

1. Coarse Sample

a. Place the sample in the oven at 110±5°C (230±9°F). or on the stove and dry to a constant mass (weight).

When drying on the stove the sample must be stirred to prevent local overheating causing the sample to "pop" or "sputter".

b. Allow the sample to cool and determine the original dry mass (weight).

c. Sieve the sample on the 4.75 mm (No. 4) sieve.

d. Wash the material retained on the 4.75 mm (No.4) sieve by either; placing it on a 4.75 mm (No.4) sieve and agitate the sieve and its contents in a tub of water, or, place the material in a large pan, cover with water, agitate the pan of aggregate and decant the water from it. Repeat these steps until the decanted water appears clear. Any clay lumps present must be broken up and passed through this sieve in the washing process.

e. Place the washed sample in the oven or on the stove and dry to a constant mass (weight).

f. Allow the sample to cool and determine the washed dry mass (weight).

g. Sieve the washed and dried sample on the required coarse sieves, ending with the 4.75 mm (No.4) sieve. The sieving operation must be conducted by means of a lateral and vertical motion of the sieve, accompanied by a jarring action so as to keep the sample moving continuously over the surface of the sieve. Do not attempt to turn or manipulate the sample through the sieve by hand. Continue sieving until not more than 0.5 percent by mass (weight) of the dry mass (weight) of the washed sample passes any sieve during one minute. The above described procedure for determining the thoroughness of sieving is to be carried out with a single layer of material. When mechanical sieving is used, the thoroughness of sieving is to be tested by using the hand method of sieving as described above.

h. Weigh the material retained on each sieve and in the pan, and record. The total must equal the dry mass (weight) of the washed sample as previously recorded within 0.5 percent.

2. Fine Sample

a. First subject the sample to the "Method of Test for Determining the Amount of Material Finer than the 75 μm (No. 200) Sieve in Aggregate by Washing". Matls. I.M. 306.

b. Separate the minus 4.75 mm (No.4) material by sieving the sample over a 4.75 mm (No.4) box sieve.

c. Place the minus 4.75 mm (No.4) material on the nested sieves and begin the sieving operation by means of a lateral and vertical motion of the sieves so as to keep the sample moving continuously over the surface of the sieves. In no case should the particles in the sample be turned or manipulated through the sieves by hand.

Continue sieving until not more than 0.5 percent by mass (weight) of the dry mass (weight) of the washed sample passes any sieve during one minute. A shaker provided with an electric motor should be run for a period of at least 10 minutes. When the sieve action is such that the particles are not sieved to completion in the time allowed, the cause may be overloading of the sieves. If this condition cannot be corrected by adjusting the sample size on future tests, the washed and dried sample should be divided for sieving and then recombined for weighing.

d. Clean the retained material out of the sieves for weighing, so that a minimum of material is retained in the sieve by clinging to the mesh. Particles may be removed most readily from a sieve by inverting the sieve over a pan and tapping the sieve and/or pushing (without force) the particles out of the mesh into the pan. Care should be exercised in cleaning the sieves to not damage the wire mesh by bending or breaking the wires. A brush should be used for cleaning the 1.18 mm (No.16), 600 μm (No.30), and 300 μm (No.50) sieves. Do not use a brush or any external force to attempt to clean the 150 μm (No.100) or 75 μm (No.200) sieve. Gentle tapping of the sieve frame is recommended for these sieves. If clogging of the mesh occurs on these finer sieves, they should be returned to the central laboratory for cleaning.

e. Weigh and record the fractions of material on each sieve and pan. Any material retained on the 4.75 mm (No.4) round sieve must be combined with material retained on the 2.36 mm (No.8) sieve for weighing. The combined mass (weight) of material retained on all the sieves and within the pan must equal the original mass (weight) after washing within 0.5 percent.

The original dry mass (weight) of the sample must also be within 0.5 percent of the mass (weights) on each sieve and in the pan plus the washing loss. If the difference exceeds 0.5 percent check for a subtraction error in the washing loss.

f. The total amount of material finer than the No. 75 μm (No. 200) sieve is determined by adding the mass (weight) of materials passing the No. 75 μm (No. 200) sieve by dry sieving to that lost by washing.

E. Calculations

1. The percentage of the coarse sample retained on each of the sieves is computed by dividing the mass (weight) retained on each sieve by the

original dry mass (weight) of the sample, and multiplying the result by 100. The computations should be checked by totaling the percentages retained on the various sieves. This figure should equal the result obtained by dividing the total plus 4.75 mm (No.4) material by the original dry mass (weight) and multiplying by 100. If a difference exists, the latter figure will be considered correct, and the difference prorated over the sieves.

2. Using the mass (weight) of material passing the 4.75 mm (No.4) sieve, as determined on the fine sample, compute the percentages retained by dividing the mass (weight) retained on each of the sieves by the weight passing the 4.75 mm (No.4) sieve, and multiplying by 100. (The percentage retained on the 4.75 mm (No.4) sieve is <u>not</u> computed for this sample.) These percentages retained should total 100.0. If the total is not exactly 100.0 the percentages should be altered by prorating the difference so they do total 100.0. It will be noted that the washing loss and the material in the pan are added together to compute the percentage retained in the pan.

3. The values determined in D-2 represent only the percentages retained as based on the material passing the 4.75 mm (No.4) sieve. To convert these percentages to the basis of total material, they must be multiplied by the percentage passing the 4.75 mm (No.4) sieve (as determined for the coarse sample) and divided by 100. The sum of these percentages must equal the percentage passing the 4.75 mm (No.4) sieve as determined on the coarse sample. These values are subtracted successively from the percentage passing the 4.75 mm (No.4) sieve to complete the sieve analysis.

4. In computing the percentage retained and subsequent percentage passing each sieve, the computations are carried out to the nearest 0.1 percent so that the percentages retained will add to a total of 100 percent. In reporting the sieve analysis, however, these results are shown only to two significant figures, i.e., to the nearest percent for percentages above 10.0, and to the nearest tenth of a percent for lower results.

Combined Aggregate Sieve Analysis
Example

Aggregate for 19 mm (3/4") Type A Asphaltic Concrete.
Minimum Size Sample Required (I.M. 301) = 2,500 g.
Estimated Percentage Passing 4.75 mm (No.4) Sieve = 50%
Estimated Percentage Passing 75 µm (No.200) Sieve = 10%
Approximate Wet Mass (Weight) of Fine Sample to obtain equals:

$$\frac{50 \text{ X } 100}{\%\text{Psg } 4.75 \text{ mm (No.4)}} = \frac{550 \text{ X } 100}{50} = 1100 \text{ g. (Approx.)}$$

Dry Mass (Coarse Sample) = 2800 g.
Dry Mass (Fine Sample) = 1045 g.
Dry Mass Washed Sample (Coarse) = 1306 g.
Dry Mass Washed Sample (Fine) = 965 g.

% Retained on Coarse Sample

19 mm (3/4") = (0 X 100) ÷ 2800 = 0.0%
13.2 mm (0.530") = (224 X 100) ÷ 2800 = 8.0%
9.5 mm (3/8") = (490 X 100) ÷ 2800 = 17.5%
4.75 mm (No.4) = (590 X 100) ÷ 2800 = 21.1%
Total 4.75 mm (No.4) =(1304 X 100) ÷ 2800 = 46.6%

% Retained on Fine Sample

2.36 mm (No.8) = (157 X 100) ÷ 554 = 28.3% Prorate to 28.2
1.18 mm (No.16) = (73 X 100) ÷ 554 = 13.2%
600 µm (No.30) = (94 X 100) ÷ 554 = 17.0%
300 µm (No.50) = (42 X 100) ÷ 554 = 7.6%
150 µm (No.100) = (52 X 100) ÷ 554 = 9.4%
75 µm (No.200) = (32 X 100) ÷ 554 = 5.8%
Wash & Pan = (80+24 X 100) ÷ 554 = 18.8%

% Retained Final

2.36 mm (No.8) = (28.2 X 53.4) ÷ 100 = 15.1%
1.18 mm (No.16) = (13.2 X 53.4) ÷ 100 = 7.0%
600 μm (No.30) = (17.0 X 53.4) ÷ 100 = 9.1%
300 μm (No.50) = (7.6 X 53.4) ÷ 100 = 4.1%
150 μm (No.100) = (9.4 X 53.4) ÷ 100 = 5.0%
75 μm (No.200) = (5.8 X 53.4) ÷ 100 = 3.1%
Wash & Pan = (18.8 X 53.4) ÷ 100 = 10.0%

Form 820180
10-95

Iowa Department of Transportation
SIEVE ANALYSIS WORKSHEET

Lab. No.		Material			Material			Material
Co. & Proj.								
Producer								
Contractor								
Sampled by		Date			Date			Date
Sample Loc.								

Coarse Sample

	Split Diff. .4%	Orig. Dry Mass (Weight)	2800			Split Diff.	Orig. Dry Mass (Weight)				Split Diff.	Orig. Dry Mass (Weight)			
	Tol. Check 100%	Dry Mass (Wt.) Washed Sample	1306			Tol. Check	Dry Mass (Wt.) Washed Sample				Tol. Check	Dry Mass (Wt.) Washed Sample			
Sieve Size	Mass (Wt.) Retd.	% Retd.	% Retd. X-----	% Psg. Final	**Specs.**	Mass (Wt.) Retd.	% Retd.	% Retd. X-----	% Psg. Final	**Specs.**	Mass (Wt.) Retd.	% Retd.	% Retd. X-----	% Psg. Final	**Specs.**
37.5mm (1½)															
26.5mm (1.06)															
19mm (¾)	0	0.0		100.0											
13.2mm (0.530)	224	8.0		92.0											
9.5mm (⅜)	490	17.5		74.5											
4.75mm (4)	590	21.1		53.4											
2.36mm (8)															
Total 4.75mm (4)	1304	46.6													
Pan	2														
Total	1306														

Fine Sample

		Orig. Dry Mass (Weight)	1045				Orig. Dry Mass (Weight)					Orig. Dry Mass (Weight)			
	Tol. Check 100%	Dry Mass (Wt.) Washed Sample	965			Tol. Check	Dry Mass (Wt.) Washed Sample				Tol. Check	Dry Mass (Wt.) Washed Sample			
		Washing Loss	80				Washing Loss					Washing Loss			
Sieve Size	Mass (Wt.) Retd.	% Retd.		% Passing	**Specs.**	Mass (Wt.) Retd.	% Retd.		% Passing	**Specs.**	Mass (Wt.) Retd.	% Retd.		% Passing	**Specs.**
			Final					Final					Final		
9.5mm (⅜)															
4.75mm (4)	491	--													
2.36mm (8)	157	28.32	15.1	38.3											
1.18mm (16)	73	13.2	7.0	31.3											
600µm (30)	94	17.0	9.1	22.2											
300µm (50)	42	7.6	4.1	18.1											
150µm (100)	52	9.4	5.0	13.1											
75µm (200)	32	5.8	3.1	10.0											
Wash	80														
Pan	24	18.8	10.0												
Total	1045	100.0	53.4												
Less +4.75mm (4)	491														
Passing #4.75mm (4)	554														

Date Reptd.		Date Reptd.		Date Reptd.	
Tested by	Date	Tested by	Date	Tested by	Date

METHOD OF TEST
SIEVE ANALYSIS OF COMBINED AGGREGATES
(LABORATORY METHOD)

SCOPE

This method of test describes a procedure for determining the particle size distribution of combined coarse and fine aggregates. This determination is performed with sieves having square openings.

This test method is for use only with 305 mm (12") diameter sieves.

PROCEDURE

A. Apparatus

1. Balance accurate to within 0.1% of the mass (weight) of the sample to be tested.
2. Sieves - The sieves with square openings shall be mounted on substantial frames constructed in a manner that will prevent loss of material during sieving. Suitable sieve sizes shall be selected to furnish the information required by the specifications covering the material to be tested. The woven wire cloth sieves shall conform to AASHTO M-92.
3. Oven or drying stove.
4. Mechanical sieve shaker.
5. Fiber bristle sieve cleaning brush (similar to a stencil brush or cropped paint brush).

B. Sample Size

1. Follow the method described in I.M. 336 and reduce the field sample to a test sample size that will conform with the following:

Nominal Maximum Aggregate Size	Minimum Sample Mass (Weight)
26.5 mm (1.06 in.)	2500 grams
19 mm (3/4 in.)	2000 grams
13.2 mm (0.530 in.)	1000 grams

C. Balance

1. Balance should be tared each time it is used.

D. Test Procedure

1. Place the sample in the oven at 110±5°C (230± 9°F), or on the stove and dry to a constant mass (weight).

2. Allow the sample to cool and determine the original sample mass (weight) to the nearest 0.5 gm.

3. Determine the amount of minus 75 μm (No. 200) sieve size, by washing the entire sieve analysis test sample as described in I.M. 306.

4. Place the washed sample in the oven or on the stove and dry to a constant mass (weight).

5. Allow the sample to cool and determine the washed dry mass (weight) to the nearest 0.5 gm.

6. Sieve the washed and dried sample on the required coarse sieves. This may be done by either hand sieving or using the mechanical sieve shaker. The sieving operation must be conducted by means of a lateral and vertical motion of the sieve, accompanied by a jarring action so as to keep the sample moving continuously over the surface of the sieve. Do not attempt to turn or manipulate the sample through the sieve by hand. Continue sieving until not more than 0.5 percent by mass (weight) of the dry mass (weight) of the washed sample passes any sieve during one minute. The above sieving is to be carried out with a single layer of material. When mechanical sieving is used, the thoroughness of sieving is to be tested by using the hand method of sieving as described above.

7. Sieve the portion of the sample that passed the coarse sieves on the nest of fine sieves with the mechanical shaker. This sieving is done in the same manner as described in C-6.

8. Clean the retained material out of the sieves for weighing, so that a minimum of material is retained in the sieve by clinging to the mesh. Particles may be removed most readily from the sieve by inverting the sieve over a pan and topping the sieve and/or pushing (without force) the particles out of the mesh into the pan. Care should be exercised in cleaning the sieves not to damage the wire mesh by bending or breaking the wires. A brush should be used for cleaning the 1.18 mm

(No. 16), 600 μm (No. 30) and 300 μm (No. 50) sieves. Do not use a brush or any external force to attempt to clean the 150 μm (No. 100) and 75 μm (No. 200) sieve. If clogging of the mesh occurs on these finer sieves they should be returned to either the Central or Transportation Center Laboratory for cleaning.

9. Record the mass (weight) of the material retained on each sieve and the pan. The combined mass (weight) of the material retained on all sieves and in the pan must equal the dried mass (weight) after washing to within 0.5 percent.

E. Calculation

1. Determine the mass (weight) of aggregate passing the 75 μm (No. 200) sieve by adding the mass (weight) of material retained in the pan by dry sieving to the mass (weight) loss by washing.

2. Record the percentages retained on each sieve to the nearest 0.1 percent. If this total does not add up to 100 percent, the sieves having the larger percentages retained must be prorated to due so.

3. Calculate the percent passing to the nearest 0.1 as follows:

   a. Subtract the percent retained on the largest sieve size used from 100 to determine percent passing this sieve.
   b. To determine the percent passing subsequent sieves, the percent retained on the sieve is subtracted from the percent passing the previous one.
   c. The amount of material passing the 75 μm (No. 200) sieve is the combined mass (weight) of the amounts washed through the 75 μm (No. 200) wash sieve and retained in the pan after dry sieving. Divide this combined mass (weight) by the original dry mass (weight) of the sample to determine the percent passing the 75 μm (No. 200) sieve. This must equal the calculated percent passing as determined in step D-2.

Note: Test results of "split samples" that do not correlate must be retested in accordance with I.M. 304.

I.M. 305 Test Method
Example

Original Dry Weight of Sample = 1747.5
Dry Sample Weight After Washing = 1540.1

Sieve Size	Weight Retained (g)
26.5 mm (1.06")	0.0
19 mm (3/4")	10.9
13.2 mm (0.530")	48.0
9.5 mm (3/8")	142.4
4.75 mm (4)	311.4
2.36 mm (8)	246.9
1.18 mm (16)	182.6
600 µm (30)	132.2
300 µm (50)	194.1
150 µm (100)	186.4
75 µm (200)	73.7
Pan	6.2

1534.8 ÷ 1540.1 = 99.7%

Therefore this weight loss from sieving is within the 0.5% tolerance.

Sieve No.	%Retained	(Prorated)	Passing	(Reportable)
26.5 mm (1.06)	0.0 ÷ 1747.5 = 0	0.0	100	100
19 mm (3/4)	10.9 ÷ 1747.5 = 0.6	0.6	99.4	99
13.2 mm (0.530)	48.0 ÷ 1747.5 = 2.7	2.7	96.7	97
9.5 mm (3/8)	142.4 ÷ 1747.5 = 8.1	8.1	88.6	89
4.75 mm (4)	311.4 ÷ 1747.5 = 17.8	18.0	70.6	71
2.36 mm (8)	246.9 ÷ 1747.5 = 14.1	14.2	36.4	36
1.18 mm (16)	182.6 ÷ 1747.5 = 10.4	10.5	45.9	46
600 µm (30)	132.2 ÷ 1747.5 = 7.6	7.6	38.3	38
300 µm (50)	194.1 ÷ 1747.5 = 11.1	11.1	27.2	27
150 µm (100)	186.4 ÷ 1747.5 = 10.7	10.7	16.5	17
75 µm(200)	73.7 ÷ 1747.5 = 4.2	4.2	12.3	12
Pan & Wash	213.6 ÷ 1747.5 = 12.2			
	99.5			

Form 820180
10-95

Iowa Department of Transportation
SIEVE ANALYSIS WORKSHEET

Lab. No.	Material	Material	Material
Co. & Proj.			
Producer			
Contractor			
Sampled by	Date	Date	Date
Sample Loc.			

Coarse Sample

	Coarse Sample	Coarse Sample	Coarse Sample
Split Diff.	Orig. Dry Mass (Weight) 1747.5	Split Diff. / Orig. Dry Mass (Weight)	Split Diff. / Orig. Dry Mass (Weight)
Tol. Check 99.7%	Dry Mass (Wt.) Washed Sample 1540.1	Tol. Check / Dry Mass (Wt.) Washed Sample	Tol. Check / Dry Mass (Wt.) Washed Sample

Sieve Size	Mass (Wt.) Retd.	% Retd.	% Retd. X-----	% Psg. Final	Specs.	Mass (Wt.) Retd.	% Retd.	% Retd. X-----	% Psg. Final	Specs.	Mass (Wt.) Retd.	% Retd.	% Retd. X-----	% Psg. Final	Specs.
37.5mm (1½)															
26.5mm (1.06)	0.0	0.0		100%											
19mm (¾)	10.9	0.6		99.4											
13.2mm (0.530)	48.0	2.7		96.7											
9.5mm (⅜)	142.4	8,1		88.6											
4.75mm (4)	311.4	17.~~8~~ 18.0		70.6											
2.36mm (8)															
Total 4.75mm (4)															
Pan															
Total															

Fine Sample

	Fine Sample	Fine Sample	Fine Sample
	Orig. Dry Mass (Weight)	Orig. Dry Mass (Weight)	Orig. Dry Mass (Weight)
Tol. Check	Dry Mass (Wt.) Washed Sample	Tol. Check / Dry Mass (Wt.) Washed Sample	Tol. Check / Dry Mass (Wt.) Washed Sample
	Washing Loss	Washing Loss	Washing Loss

Sieve Size	Mass (Wt.) Retd.	% Retd.	% Retd. Final	% Passing	Specs.	Mass (Wt.) Retd.	% Retd.	% Retd. Final	% Passing	Specs.	Mass (Wt.) Retd.	% Retd.	% Retd. Final	% Passing	Specs.
9.5mm (⅜)															
4.75mm (4)															
2.36mm (8)	246,9	14,12		56.4											
1.18mm (16)	182.6	10.45		45.9											
600μm (30)	132.2	7.6		38.3											
300μm (50)	194.1	11.1		27.2											
150μm (100)	186.4	10.7		16.5											
75μm (200)	73.7	4.2		12.3											
Wash	207.4	> 12.23													
Pan	6.2														
Total	1742.2	~~99.5~~ 100.0													
Less +4.75mm (4)															
Passing #4.75mm (4)															

Date Reptd.		Date Reptd.		Date Reptd.	
Tested by	Date	Tested by	Date	Tested by	Date

NOTES

Iowa Department of Transportation

HIGHWAY DIVISION - OFFICE OF MATERIALS
INSTRUCTIONAL MEMORANDUM

November 1993
Supersedes Nov. 1992

Matls. I.M. 306
Page 1 of 3

METHOD OF TEST
DETERMINING THE AMOUNT OF MATERIAL FINER THAN THE NO. 200 SIEVE IN AGGREGATE BY WASHING
Field Procedure for Lab. Test Method 206

SCOPE

This test method outlines the procedure for determining the quantity of material finer than a No. 75 µm (200) sieve by washing. This procedure may not determine the total amount of material finer than the No. 75 µm (200) sieve. Such a determination may be made by a combination of washing and dry sieving.

PROCEDURE

A. Apparatus

1. A No. 75 µm (200) sieve (wash sieve).
2. A wash pan large enough to prevent loss of water and material.
3. Oven or drying stove.
4. Balance accurate to 0.1 percent of the sample weight.

B. Test Sample

1. Select the test sample from material which has been thoroughly mixed and which contains sufficient moisture to prevent segregation. A representative sample, sufficient to yield not less than the appropriate weight of dried material, as show in the following table shall be selected:

Sieve Analysis Sample Weight kg. See matls. IM 301	Appropriate Minimum Weight of Sample kg.
10.0	2.5
5.0	2.5
2.5	1.0
1.0	*
0.5	*
0.1	*

---

*Use entire sample

C. Test Procedure

1. Place the damp sample in the oven at 110°C. (230°F.) or on the stove and allow it to come to a constant weight. Care must be taken in drying the sample to avoid over heating causing the sample to "pop" or "sputter". ←

2. Allow the sample to cool and determine the dry weight.

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

4. Agitate the sample vigorously by a rotary motion of the pan for 5 to 10 seconds.

5. Pour off the water through the No. 75 µm (200) wash sieve. In washing samples with a high silt content, it may be necessary to vibrate or lightly tap the No. 75 µm (200) sieve in order to keep the mesh open so that the water may pass through freely. Repeat this operation until the wash water appears almost clear.

6. Rinse the material retained on the No. 75 µm (200) sieve back into the sample and decant as much water as possible (by carefully pouring the water through the No. 75 µm (200) sieve).

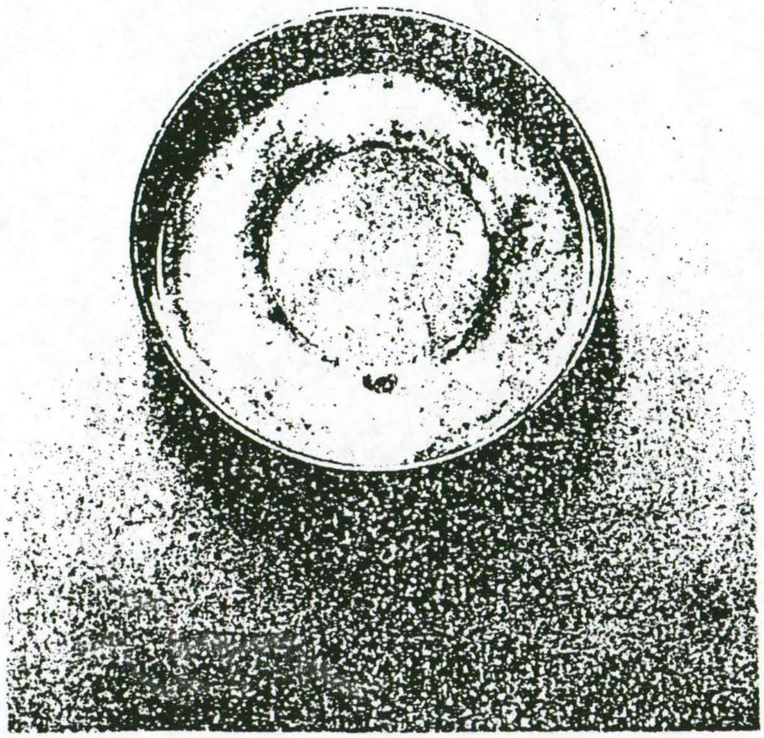
7. Dry the washed sample, allow to cool, and weigh.

D. Calculations

1. Calculate the results from the following formula:

% finer than No. 75 µm (200) =

$$\frac{\text{Orig. dry wt.} - \text{Washed dry wt.}}{\text{Original Dry Wt.}} \times 100$$



No. 75 μm (200) Wash Sieve

NOTES

METHOD OF REDUCING AGGREGATE SAMPLES BY QUARTERING OR SPLITTING

SCOPE

This method outlines the proper procedure for reducing an aggregate sample to the proper test size by the quartering or splitting methods.

QUARTERING METHOD

A. Apparatus

1. Shovel
2. Brush

B. Test Procedure

1. Place the sample on a hard, clean, smooth surface where there will be neither loss of material from the sample, nor the accidental addition of foreign material.
2. Mix the sample thoroughly by turning the entire lot over three times with a shovel. With the last turning, shovel the entire sample into a conical pile by depositing each shovelful on top of the preceding one.
3. Carefully flatten the conical pile to a uniform thickness and diameter by pressing down the apex with a shovel, so that each quarter will contain the amount of material originally in it.
4. Mark the flattened mass into quarters by two lines that intersect at right angles at the center of the pile.
5. Remove two diagonally opposite quarters and brush the cleared spaces clean.
6. Successively mix and quarter the remaining material as above, until the sample is reduced to the desired size, with the two remaining quarters giving the sample for test.

SPLITTING METHOD

A. Apparatus

1. Sample splitter
2. 3 catch pans
3. Wide, flat-edge scoop

B. Test Procedure

1. Place the field sample on a hard clean surface such as a counter top, concrete floor, or in a large flat pan.

2. Thoroughly mix the field sample until it appears homogeneous.

3. Place a catch pan under the chutes on each side of the splitter.

4. Place increments of the field sample on the wide flat-edge scoop and uniformly distribute it from edge to edge, so that when it is introduced into the chutes, approximately equal amounts will flow through each chute.

5. Repeat the above step until all of the field sample has been introduced into the chutes. It may be necessary to use a brush to collect the fine material of the sample for splitting.

6. The rate at which the sample is introduced shall be such as to allow a free flow of material, from the scoop, through the chutes into the catch pans below.

7. Use the material contained in one of the catch pans and repeat the previous steps (B-1, 2 and 3) until the sample is reduced to the desired size.

C. General

1. If the catch pans are equal to or slightly less than the total combined width of the riffle chutes, they may be used to place the material on the splitter in lieu of using the scoop. <u>Do not</u> use containers longer than the combined width of the riffle chutes, however, as this results in an over-loading of the end chutes.

2. Use the size of sample splitter best suited for the maximum particle size of the aggregate to be tested. Generally use the splitters with 25 mm (1 in) riffle openings for aggregates with a 19 mm (3/4 in) maximum particle size, and the splitters with 50 mm (2 in) openings for samples containing larger particle sizes.

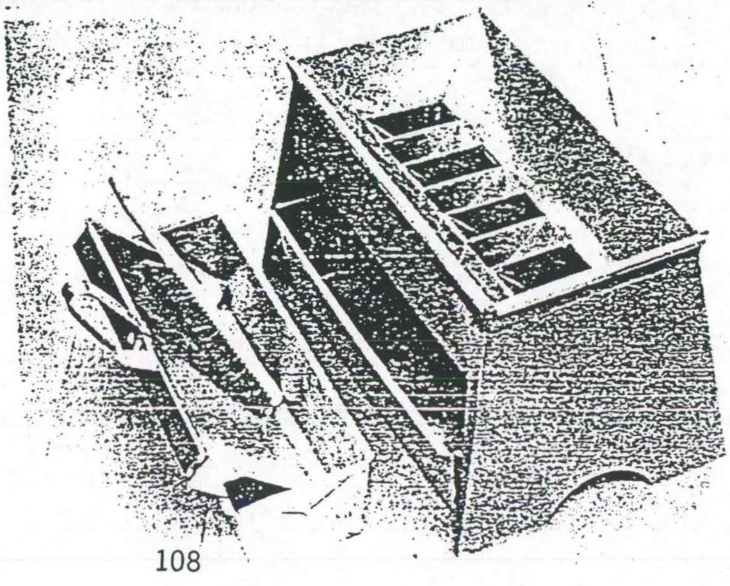


Figure 1
50 mm (2 in) Sample Splitter

MECHANICAL SPLITTER METHOD

A. Apparatus

1. Mechanical Sample Splitter
2. 10 Catch Pans
3. Buckets
4. Shovel

B. Test Procedure

1. Place the ten small pans of the splitter in the appropriate area of splitter.
2. Place the entire field sample in buckets. Turn on splitter and pour material slowly into the top of hopper.
3. Complete pouring of entire field sample into hopper (catch pans will hold one bag without overflowing). If more than one bag is used, you will have to pour each catch pan into separate larger containers and then resume splitting. It may be necessary to use a brush to collect the fine material of the sample.
4. Use all the material contained in one or more of the catch pans to obtain the desired size.

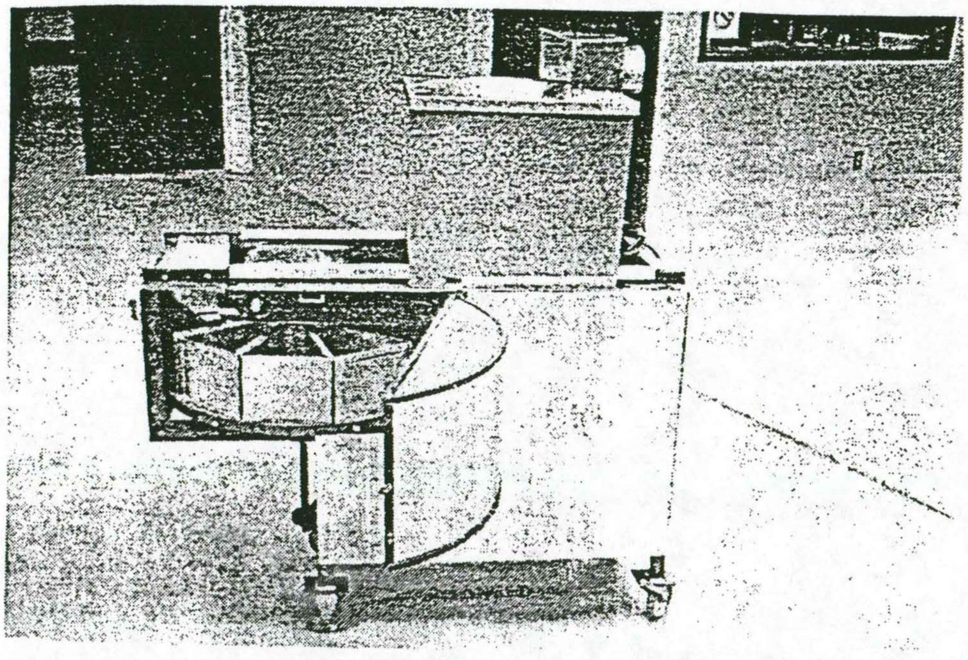


Figure 2
Mechanical Sample Splitter

NOTES

SECTION V

AGGREGATE SOURCE INSPECTION

Aggregate source inspection involves monitoring the quality of the material being produced from an approved source. Prior to being designated as an approved source, preliminary testing or production will usually have occurred at the site to establish the potential quality of material obtainable. Although at times further assurance samples are required, most construction aggregates are delivered to a project with the only quality requirement being that they were obtained from an approved source. This can be done because the quality level of an aggregate as measured by soundness or abrasion tests remains essentially the same unless some significant change has occurred, either in the material or in the manner in which it was produced. It is the responsibility of the Aggregate Technician to recognize when any such change has occurred and to obtain such samples as necessary to establish the quality of aggregate being produced under the changed conditions. The factors causing change are somewhat different in quarries than in sand and gravel pits and each shall be covered separately.

QUARRIES

QUARRY - A deposit of ledge rock from which the rock is excavated by cutting or blasting.

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

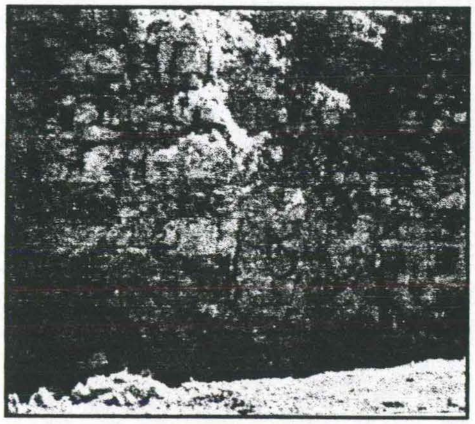
a) Ledge Control: The quarry ledge has not been maintained in the same beds.

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

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

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

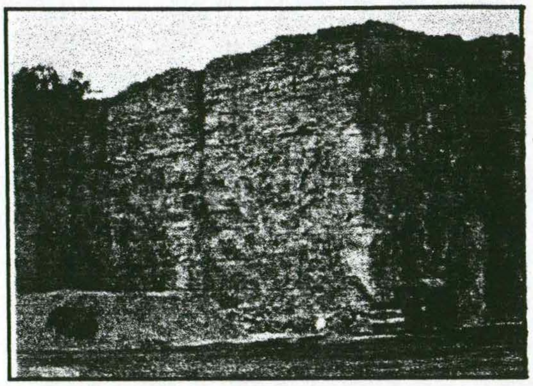
e) Production Changes: Production methods have changed to the extent that a similar product is not being obtainied.



Close-up of verticle fault. Note the different bedding planes as the fault zone is crossed and the possible overall quality changes that may be encountered.

LEDGE CONTROL

As an aid in identifying the various beds and/or quality units in a quarry, geologic sections have been prepared for most sources (Figure 3.1). The various beds are identified by a number and a description. The geologic age of the source is also noted and the relative position of the source age-wise can be found on a time chart such as Figure 3.2. Every layer or bed of rock in a quarry can be quite different in quality while often times quite similar visibly. Consequently, when material is being produced on the basis of previously established quality, we must be sure that the quarry ledge is in the same beds as 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.

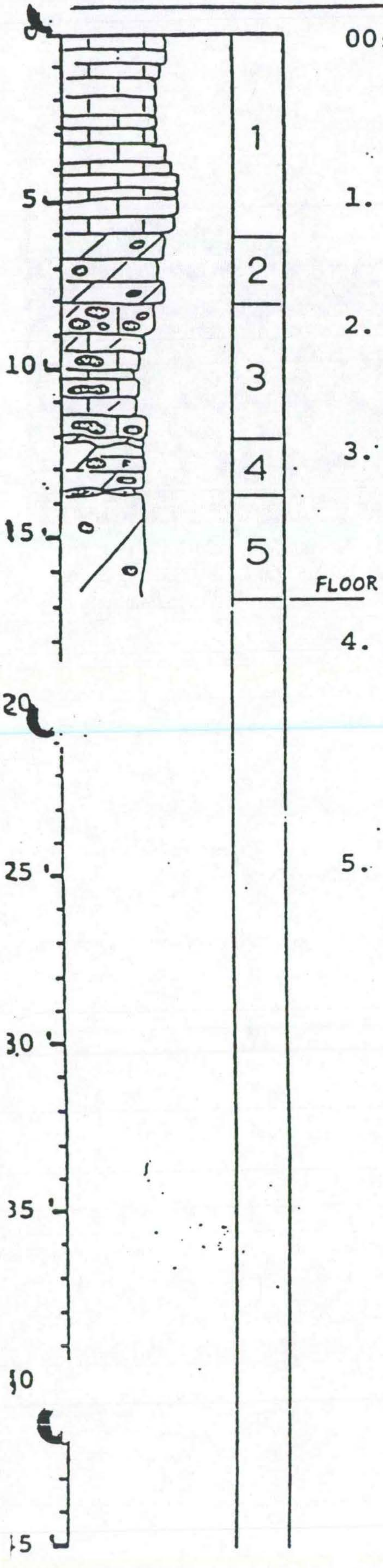


Skyline Quarry (Winneshiek Co.) - a quarry with good traceable bedding breaks and unique fossils to aid in maintaining proper ledges.

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

4-3

Peterson	5/6/75	SW¼ Sec. 23 T. 95 R. 15 Co. Floyd Carville Qr. 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. ±

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

3. Limestone; light, pinkish gray; medium crystalline; dolomitic; many large calcit-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. 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 "birdseye" calcite; massive but fractured; hard. ±3

FIGURE 3.1

STRATIGRAPHIC COLUMN OF IOWA

SYSTEM	SERIES	GROUP	FORMATION	DESCRIPTION	THICKNESS (feet)	AGE (in millions of years before present)
Quaternary	Pleistocene		Wisconsin	loess, glacial till and interbedded sand and gravel	500'	
			Illinoian			
			Kansan			
			Nebraskan			2-3
Cretaceous		Colorado	Carlile	shale	350'	
			Greenhorn	limestone and shale		
			Graneros	shale		
		Dakota		sandstone and shale	200'	130
Jurassic	-		Fort Dodge beds	gypsum, red and green shales in Webster County only	50'	185
Pennsylvanian	Virgil	Wabaunsee	French Creek	shale	210'	
			Jim Creek	limestone		
			Friedrich	shale		
			Grandhaven	limestone		
			Dry	shale		
			Dover	limestone		
			Langdon includes (Nyman Coal)	shale		
			Maple Hill	limestone		
			Wamego	shale		
			Tarkio	limestone		
			Willard	shale		
			Elmont	limestone		
			Harveyville	shale		
			Reading	limestone		
			Auburn	shale		
			Wakarusa	limestone		
			Soldier Creek	shale		
			Burlingame	limestone		
			Silver Lake	shale		
			Rulo	limestone		
			Cedar Vale (includes Elmo bed at top)	shale		
			Happy Hollow	limestone		
			White Cloud	shale		
			Howard	limestone		
			Severy (includes Nodaway coal bed at base)	shale		
Pennsylvanian		Shawnee	Topeka	limestone	180'	
			Calhoun	shale		
			Deer Creek	limestone		
			Tecumseh	shale		
			Lecompton	limestone		
			Kanwaka	shale		
			Oread	limestone		
		Douglas	Lawrence	shale	110'	
			Stranger	shale		
			Iatan	limestone		
			Weston	shale		
	Missouri	Lansing	Stanton	limestone	50'	
			Vilas	shale		
			Plattsburg	limestone		
		Kansas City	Bonner Springs	shale	215'	
			Wyandotte	limestone and shale		
			Lane	shale		
			Iola	limestone and shale		
			Chanute	shale		
			Drum	limestone		
			Quivira	shale		
			Westerville	limestone		
			Cherryvale	shale		
			Dennis	limestone and shale		
			Galesburg	shale		
			Swope	limestone		
			Ladore	shale		
			Hertha	limestone		
		Pleasanton	undifferentiated	shale and sandstone, thin coal beds	40'	
	Des Moines	Marmaton	Lenapah	limestone	145'	
			Nowata	shale		
			Altamont	limestone and shale		
			Bandera	shale		
			Pawnee	limestone and shale		
			Labette	shale		
			Fort Scott	limestone		
		Cherokee	undifferentiated	shale, sandstone, thin limestones and coal	755'	310

FIG. 3.2

STRATIGRAPHIC COLUMN OF IOWA

SYSTEM	SERIES	GROUP	FORMATION	DESCRIPTION	THICKNESS (feet)	AGE (in millions of years before present)
Mississippian	Meramec		Ste. Genevieve	shale and limestone	140'	
			St. Louis	sandy limestone		
			Spergen	limestone		
	Osage		Warsaw	shale and dolomite	250'	
			Keokuk	cherty dolomite and limestone		
			Burlington	cherty dolomite and limestone		
	Kinderhook		Gilmore City	limestone, oolitic	300'	
			Hampton	limestone and dolomite		
		North Hill	Starrs Cave	limestone	100'	
			Prospect Hill	siltstone		
			McCraney	limestone		355
Devonian	Upper	Yellow Spring	English River	siltstone	300'	
			Maple Mill	shale		
			Aplington	dolomite		
			Sheffield	shale		
			Lime Creek	dolomite and shale	225'	
			Shell Rock	limestone and dolomite		
	Middle		Cedar Valley	limestone and dolomite	270'	
			Wapsipinicon	limestone and dolomites, shales in middle		
	Lower		La Porte City	chert, limestone and dolomite	50 - 100'	410-415
Silurian	Niagaran		Gower	dolomite	300'	
			Hopkinton			
	Alexandrian		Kankakee	cherty dolomite	100'	
			Edgewood	sandy dolomite		425
Ordovician	Cincinnatian		Maquoketa	dolomite and shale	300'	
	Mohawkian		Galena	dolomite and chert	320'	
			Decorah	limestone and shale		
			Platteville	limestone, shale and sandstone	70'	
	Chazyan		St. Peter	sandstone	50 - 230'	
	Beekmantown		Prairie du Chien	sandy and cherty dolomite and sandstone	290'	475
Cambrian	St. Croixan	Trempealeau	Madison[a]	sandstone	185'	
			Jordan			
			Lodi[a]			
			St. Lawrence	dolomite		
			Franconia	glauconitic sandstone, siltstone, shale	160'	
		Dresbach	Galesville	sandstone	550'	
			Eau Claire	sandstone and shale, dolomite		
			Mt. Simon	sandstone		570
Precambrian				sediments (sandstones), igneous, and metamorphic rocks		

[a] recognized only in extreme northeast Iowa

FIG 3.2

NOTES

NOTES

remaining in the same beds and the 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 coarse aggregate for portland cement concrete and graded stone base.
>
> Does the production history indicate that the finished product will be borderline on quality or well within the requirements?
>
> What is the quality level of the beds which might be added to the ledge?
>
> Could the 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.

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 Formation), 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.

NOTES

Lateral Variations Due to Weathering: Generally, the upper beds of any quarry that are above the ground water table will oxidize to a buff or brown color. They may have been partially dissolved and become quite friable and soft. This can lower the resistance to abrasion considerably but usually has little effect on soundness. Sometimes the clay overburden of a quarry has infiltrated the upper beds to the extent that they become undesirable. Both of these situations can usually be handled satisfactorily on a judgment basis. When uncertain, consult appropriate supervisor.

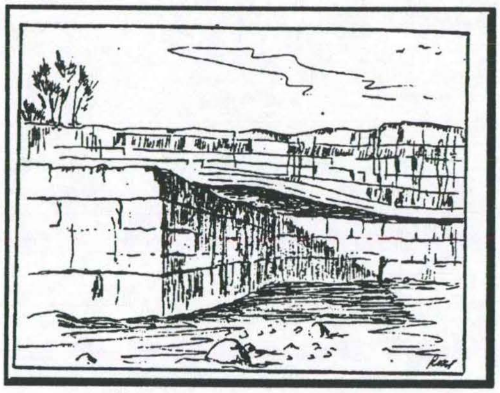


Figure 4.1

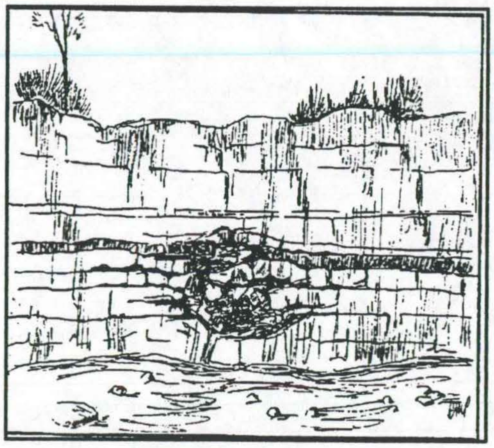


Figure 4.2

Lateral Variations Inherent to the Rock: These can be caused by actual compositional 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 Meramecian 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 thicknesses 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 transgressing a fault will suddenly be working differentbeds depending on the amount of movement

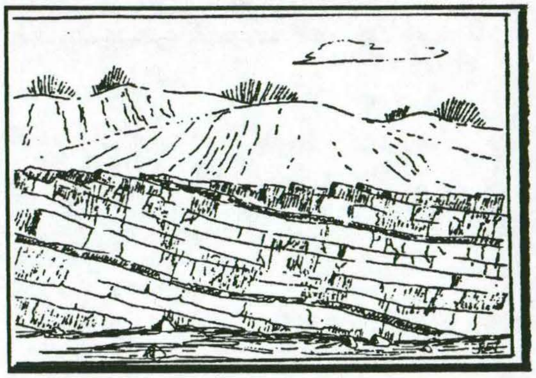


Figure 5.1

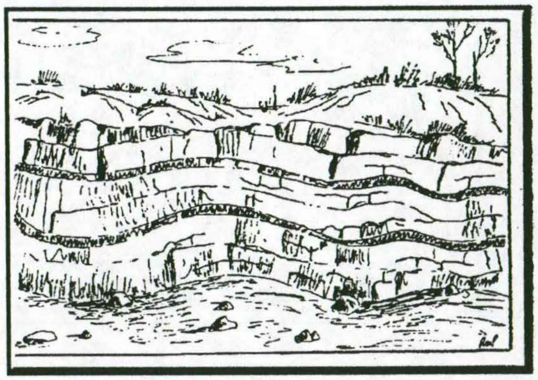


Figure 5.2

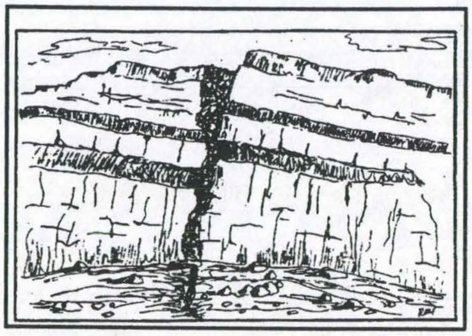


Figure 5.3

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 joint 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 and Cedar Valley Formations, massive rock units with well developed joint systems.

DELETERIOUS MATERIALS

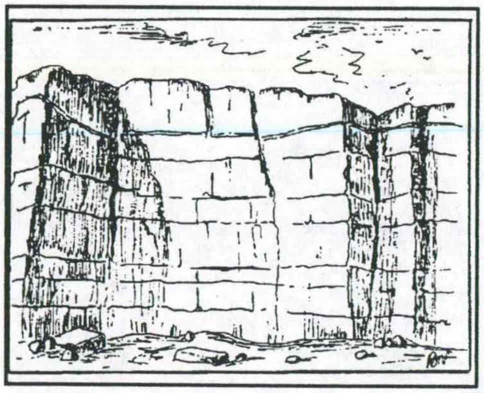


Figure 6.1

Ground water moving along vertical joints and horizontal bedding planes has often left large void spaces in the rock. These frequently are 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 quality but the contained clay pockets can become very troublesome (Figure 6.2). The clay content of aggregates being produced from this type of rock should be monitored closely when there are limits placed on clay lumps, clay balls, etc.

Figure 6.2

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 (¾ 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 benefication.

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.

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 faceto blend the material before it is processed in the plant.

They are generally in or adjacent to the many streams and rivers in Iowa or in glacial outwash deposits where the melting glacier ice had 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.

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 aggregates perform only moderately well in pavements because, despite containing relatively high percentages of extremely durable igneous materials, they also contain significant percentages of good to poor quality limestones, 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.

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PROJECT DEVELOPMENT DIVISION - OFFICE OF MATERIALS
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FIELD EQUIPMENT CLEANING, CALIBRATION, AND REPAIR

GENERAL

Various items of field testing equipment require periodic calibration to ensure reliable results. Specific items requiring calibration are balances and weights, concrete air meters, and concrete beam testing machines, etc.

The Central Materials Laboratory of the Iowa Department of Transportation will, when possible, calibrate and repair testing equipment for county and municipal government; and private organizations.

COUNTY & MUNICIPAL GOVERNMENTS

County owned equipment will be cleaned, calibrated and repaired as time permits. For any necessary repair parts, cleaning, etc., the county be billed. If extensive repair or modification to equipment is required, the county will be billed for parts and labor. Prior to any extensive repair, the County Engineer will be notified with an estimate of the cost and authorization to proceed must be received prior to the work.

Municipal governments that have projects involving state or federal funding may also have their equipment cleaned, calibrated, and repaired. Charges shall be the same as those imposed upon counties.

PRIVATE ORGANIZATIONS

Testing equipment owned by private organizations will be cleaned, calibrated, and repaired when the Department of Transportation requires certified technicians be utilized. A charge will normally be made when calibrating or repairing this equipment. Extensive repairs will be billed at actual cost plus labor charges. Prior to extensive repairs the organization will be notified with an estimate of the cost and authorization to proceed must be received prior to the work.

NONSTANDARD EQUIPMENT

The Department of Transportation is not responsible for repairing equipment that is not normally used by the Department and for which replacement parts are not normally stocked by the Central Laboratory.

BILLING PROCEDURE

Upon written notification of the Office of Materials, the Office of Accounting will bill the appropriate agency or organization.

NOTES

Iowa Department of Transportation

HIGHWAY DIVISION - OFFICE OF MATERIALS
INSTRUCTIONAL MEMORANDUM

November 1992
Supersedes May 1986

Matls. IM 344
Page 1 of 2

METHOD OF TEST FOR DETERMINATION OF THE AMOUNT OF SHALE IN FINE AGGREGATE
(Field Procedure of Iowa Test Method 209)

SCOPE

This test method covers the procedure for the approximate determination of the shale content in fine aggregate.

PROCEDURE

A. Apparatus

1. Balance having a capacity of not less than 1000 gm. and sensitive to at least 0.1 gm.

2. A strainer with openings smaller than 1.18 mm(#16 sieve) ←

3. Two bowls of sufficient capacity

4. A solution of zinc chloride ($Zn\ Cl_2$) having a specific gravity between 1.950 and 1.999 at 21°C(70^{0}F). ←
   NOTE: To prepare one gallon of solution, slowly add 12.5 pounds of technical grade zinc chloride to 4.75 pints of water with constant stirring. CAUTION: - The zinc chloride is added slowly to all the needed water to avoid generating excessive heat during the dissolving process. When all zinc chloride is in solution, cool to 21°C(70^{0}F) ← and measure Specific Gravity with a hydrometer. If the Sp. G. is below 1.95, add zinc chloride in 0.5 pound increments until the Sp. G. of the solution is at least 1.95 at 21°C(70^{0}F). ← It may be necessary to heat the original solution slightly in order to dissolve additional zinc chloride in a reasonable time.

5. Drying oven or hot plate.

6. Mixing spoon.

B. Test Procedure

1. The test sample is the quantity of material retained on the 1.18 mm (No. 16) sieve after the sieve analysis on fine aggregate (I.M. 302) has been completed. ←

2. Pour the zinc chloride solution into a mixing bowl until the volume of the liquid is at least 3 times the absolute volume of aggregate.
   NOTE: Caution - There is no particular hazard from the fumes of the zinc chloride solution but goggles and gloves should be worn to prevent contact with the eyes or skin.

3. Stir the fine aggregate sample into the solution until all particles are coated.

4. Pour the liquid off into a second container, passing it through the strainer. Take care that only the floating pieces are poured off and that none of the fine aggregate is decanted onto the skimmer.

5. Return to the first container the liquid that has been collected in the second container and after further agitation of the sample by stirring, repeat the decanting process just described until the sample is free of floating pieces.

6. Thoroughly wash the removed particles in the strainer to remove the zinc chloride. Dry to a constant weight in an oven at a temperature of 110±5°C (230±9°F) or on a hot plate at a low heat setting. Weigh to the nearest 0.1 gm.

C. Calculations

1. Calculate the percentage of shale (or shale and other low specific gravity materials) by the following formula:

$$\%\text{Shale} = \frac{\text{Dry weight of washed decanted particles}}{\text{*Dry weight of original sieve analysis sample}} \text{ X } 100$$

*This weight includes the weight of the material passing the U.S. Std. No. 16 sieve.

Iowa Department
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METHOD OF TEST FOR DETERMINATION OF THE AMOUNT OF SHALE IN COARSE AGGREGATE

(Field Procedure of Iowa Test Method 210)

SCOPE

This test method covers the procedure for the approximate determination of the shale content in coarse aggregate. This method separates, along with the shale, other particles of low specific gravity.

PROCEDURE

A. Apparatus

1. Balance having a capacity of at least 2500 gm. and sensitive to 0.1 gm.

2. A strainer with openings not larger than 2.36 mm. (U.S. Std. No. 8 sieve size).

3. Two bowls of sufficient capacity.

4. A solution of zinc chloride (Zn Cl$_2$) having a specific gravity between 1.950 and 1.999 at 21°C(70°F).
NOTE: To prepare one gallon of solution, slowly add 12.5 pounds of technical grade zinc chloride to 4.75 pints of water with constant stirring. CAUTION: - The zinc chloride is added slowly to all the needed water to avoid generating excessive heat during the dissolving process. When all zinc chloride is in solution, cool to 21°C(70°F) and measure specific gravity with a hydrometer. If the Sp. G. is below 1.95, add zinc chloride in 0.5 pound increments until the Sp. G. of the solution is at least 1.95 at 21°C(70°F). It may be necessary to heat the original solution slightly in order to dissolve additional zinc chloride in a reasonable time.

5. Drying oven or hot plate.

6. Mixing spoon.

B. Test Procedure

1. Build up a 2500-gram sample of coarse aggregate or select the sample by quartering or splitting to insure representation.

2. Dry the sample to a constant weight in an oven at a temperature of 110±5°C (230±9°F) or on a hot plate at low heat setting with frequent stirring to avoid local overheating. Weigh to the nearest 0.1 gm.

3. Place the dried sample of aggregate in the bowl and pour the solution of zinc chloride over the aggregate until the volume of the liquid is

at least 3 times the absolute volume of the aggregate.
NOTE: <u>Caution</u> - There is no particular hazard from the fumes of the zinc chloride solution but goggles and gloves should be worn to prevent contact with the eyes or skin.

4. Agitate the aggregate by vigorously stirring with a large mixing spoon until no additional pieces float to the surface.

5. Skim off the floating particles within one minute.

6. Thoroughly wash the removed particles in the strainer to remove the zinc chloride. Dry to a constant weight in an oven at a temperature of 110±5°C (230±9°F) or on a hot plate at a low heat setting. Weigh to the nearest 0.1 gm.

7. Particles of low specific gravity other than shale may be hand-picked and removed prior to weighing.

C. Calculation

1. Calculate the percentage of shale (or shale and other low specific gravity materials) from the following formula:

$$\%\text{Shale} = \frac{\text{Dry weight of washed decanted particles}}{\text{Dry weight of sample}} \times 100$$

APPENDIX A
FORMS

I.M. 302 FINE AGGREGATE

1. Obtain a field sample.
2. Create a miniature stockpile (material wet enough?).
3. Obtain a minimum of 5 increments for the test sample (minimum of 500 grams).
4. Dry test sample to a constant mass and record the original dry mass.
5. Wash the test sample over a 75 μm (#200) sieve.
6. Dry to a constant mass, allow to cool, weigh and record the dry mass washed sample.
7. Calculate the washing loss.
8. Sieve for ten minutes in mechanical sieve shaker (9.525 mm thru 75 μm (3/8" thru #200) sieve).
9. Clean sieves and separate each increment.
10. Weigh each increment and record.
11. Add each increment and check weighing accuracy (total divided by original dry mass = 99.5% to 100.5%).
12. Divide the mass of each increment by the original dry mass and record as percent retained (make sure you add the pan and wash together for the total amount of material that passed the 75μm (#200) sieve).
13. Total the percentages retained--should be 100% (prorate if necessary).
14. Subtract consecutively, the percentages retained from 100% to obtain percent passing each sieve.
15. Check percent passing 75 μm (#200) sieve, it should be the same as percentage calculated by adding the pan and wash together and dividing by the original dry mass.

I.M. 303 COARSE AGGREGATE

1. Obtain a field sample.
2. Split two samples--1 test sample for sieving and 1 sample for wash. Refer to I.M. 301 for the size of test sample for sieving and I.M. 306 for the size of sample for washing. Make sure to split the entire field sample.
3. If sample for sieving is saturated surface dry, it may be tested as is. Drying it to a constant mass is not necessary if no "free moisture" is present.
4. Weigh the sample for sieving and record as original dry mass.
5. Screen the sample over box sieves--37.5 mm thru 2.36 mm (1½" thru #8) sieve.
6. Separate individual increments, weigh and record as mass retained. (Be sure to weigh material in the pan.)
7. Total the masses retained and check weighing accuracy (total divided by the original dry mass = 99.5% to 100.5%).
8. Calculate percent retained by dividing the masses retained by the original dry mass and record.
9. Total the percentages (should be 100%) and prorate if necessary.
10. Calculate percent passing by consecutively subtracting percentages retained on each sieve from 100%.
11. Check percent passing 2.36 mm (#8) sieve, it should be the same as percent retained in the pan.

WASH SAMPLE

12. Dry to constant mass, allow to cool, weigh and record original dry mass.
13. Wash the sample over the 75 μm (#200) sieve.
14. Dry to constant mass, allow to cool, weigh and record the dry mass washed sample.
15. Calculate the washing loss by subtracting the dry mass washed sample from the original dry mass.
16. Screen the material over a 2.36 mm (#8) sieve.
17. Take the material that passes the 2.36 mm (#8) sieve and screen that over a 1.18 mm (#16), 600 μm (#30), 75 μm (#200) sieve and pan, for a period of five minutes.
18. Weigh only the material in the pan.
19. Add the washing loss and the material in the pan.
20. Divide this total by the original dry mass and record as percent passing the 75 μm (#200) sieve.

I.M. 304 COMBINED AGGREGATE

1. Obtain a field sample.
2. Split out two separate samples, one for the coarse portion and one for the fine portion. Make sure to split the entire field sample.
3. Coarse sample should be as large as specified in I.M. 301 for the various sizes of material.
4. Fine sample should be large enough so that a minimum of 500 grams of dry material will pass the 4.75 mm (#4) sieve. (500 grams ÷ percent passing 4.75 mm (#4) sieve)

COARSE SAMPLE

5. Dry sample to a constant mass.
6. Weigh and record original dry mass.
7. Rough shake the sample over a 4.75 mm (#4) sieve.
8. Throw away any material that passes the 4.75 mm (#4) sieve.
9. Wash the coarse sample over a 4.75 mm (#4) sieve.
10. Dry to a constant mass, weigh and record as dry mass washed sample.
11. Screen over appropriate box sieves 37.5 mm thru 4.75 mm (1½" thru #4) sieve.
12. Weigh and record each increment (be sure to weigh material in the pan).
13. Add all the masses retained and record the TOTAL +4.75 mm (+#4) sieve, then continue by adding pan mass and record total.
14. Check weighing accuracy by dividing the total by the dry mass washed sample = 99.5% to 100.5%.
15. Calculate percent retained by dividing the masses retained, and TOTAL +4.75 mm (+#4) sieve by the original dry mass. (Do not calculate pan.)
16. Add each percentage retained to see if they add up to the number calculated when dividing the total +4.75 mm (+#4) sieve by the original dry mass. If the individual increments do not add up to that number, you must prorate the largest.
17. Calculate percent passing by consecutively subtracting the percentages retained from 100% - STOP AT THE 4.75 mm (#4) SIEVE!!!!!!
18. The percent retained on the total +4.75 mm (+#4) sieve when added to the percent passing the 4.75 mm (#4) sieve should equal 100%.

FINE SAMPLE

19. Dry sample to a constant mass.
20. Weigh and record original dry mass.
21. Wash the sample over a 75 μm (#200) sieve.
22. Dry to constant mass, allow to cool, weigh and record dry mass washed sample.
23. Calculate washing loss and record.
24. Thoroughly screen the sample over a 4.75 mm (#4) sieve saving the material that is retained on the 4.75 mm (#4) sieve.

    Splitting check: % retained on +4.75 mm (+#4) sieve on coarse sample has to be within 3% of % retained or +4.75 mm (+#4) sieve on fine sample.
25. Any material that has passed the 4.75 mm (#4) sieve will then be placed in the tyler screens to include the 2.36 mm thru the 75 μm (#8 thru the #200) sieve and sieved for a minimum of ten minutes.
26. Clean the sieves and separate each increment including the pan.
27. Weigh and record the +4.75 mm (+#4) sieve material (saved in step 24) and each increment from the 2.36 mm thru the 75 μm (#8 thru the #200) sieve and the pan.
28. Add each increment and check weighing accuracy (total divided by the original dry mass = 99.5% to 100.5%).
29. Calculate the amount of material that has passed the 4.75 mm (#4) sieve by subtracting the amount of material that was retained on the 4.75 mm (#4) sieve from the total. This number should be at least 500 grams.
30. SOMETHING DIFFERENT--calculate the percent retained on each sieve starting with THE 2.36 mm (#8) SIEVE by dividing the masses retained by the amount of material that has passed the 4.75 mm (#4) sieve. Add the pan and washing loss together before calculating.
31. Total these percentages--they should equal 100%. Prorate if necessary.
32. SOMETHING DIFFERENT--Calculate percent retained final by multiplying the percentages retained by the percent passing the 4.75 mm (#4) sieve in the coarse sample. Total these percentages--they should equal the percent that you multiplied by. Prorate as necessary.
33. Last step is to calculate the percent passing. This is done by consecutively subtracting the percent retained final, starting with the 2.36 mm (#8) sieve from the percent passing the 4.75 mm (#4) sieve obtained from the coarse sample.
34. Check percent passing 75 μm (#200) sieve. It should be the same as the percent retained final column calculated from the wash and pan.

I.M. 305 COMBINED AGGREGATE
(WITH 305 mm (12 in.) SIEVES)

1. Obtain a field sample.
2. Reduce the field sample (per I.M. 336) to the proper test sample size (refer to I.M. 305 for test sample size).
3. Dry test sample to a constant mass, allow sample to cool, weigh and record as Original Dry Mass.
4. Wash the test sample over the 75 μm (#200) sieve (I.M. 306).
5. Dry the washed sample to a constant mass, cool, weigh and record as Dry Mass of Washed Sample.
6. Calculate the washing loss.
7. Place the sample in the required coarse sieves and sieve in the mechanical shaker for ten minutes. (NOTE: The coarse portion may be sieved by hand over box or 305 mm (12 in.) sieves.)
8. Place the remaining fine portion -4.75 mm (-#4) sieve in the nest of 305 mm (12 in.) sieves and sieve for ten minutes in the mechanical shaker.
9. Clean the retained material from each sieve and the pan into individual containers.
10. Weigh and record each increment, including the pan.
11. Add the total mass and check the weighing accuracy (+ or -0.5%).
12. Calculate the percent retained on each sieve by dividing each mass by the Original Dry Mass (x 100). Remember to combine the washing loss and pan.
13. Total these percentages. They should equal 100. Prorate if necessary.
14. Calculate the percent passing by consecutively subtracting the percent retained, starting with the sieve that has 100% passing.
15. The percent passing the 75 μm (#200) sieve should be the same as the result obtained by adding the pan and washing loss and dividing by the Original Dry Mass in the percent retained column.

AGGREGATE GRADATION TABLE

Grad. No.	Section No.	Metric Sieve Sz. / Std. Sieve Sz. / Intended Use	37.5mm 1.5"	26.5mm 1.06"	19mm 3/4"	13.2mm 0.530"	9.5mm 3/8"	4.75mm 4	2.36mm 8	600µm 30	300µm 50	150µm 100	75µm 200	Notes
1.	4110, 4111, 4125	PCC FA, Cover Agg.					100	90-100	70-100	10-60			0-1.5	1
2.	4112	Mort. Sand						100	95-100	40-75	10-40	0-30	0-3	
3.	4115 (57,2-8)	PCC CA	100	95-100		25-60		0-10	0-5				0-1.5	14
4.	4115 (2-8)	PCC CA	100	50-100	30-100	20-75	5-55	0-10	0-5				0-1.5	
5.	4115 (67,2-8)	PCC CA		100	90-100		20-55	0-10	0-5				0-1.5	
6.	4115.06 (Repair & Overlay)	PCC CA			100	97-100	40-90	0-30					0-1.5	
7.	4117 (Class V)	FA & CA	100					80-92	60-75	20-40				
8.	4117.03 (Class V add.)	Fine Lmst.						90-100					0-30	
10.	4120.03 (C gravel)	Gran. Surf.			100			50-80	25-60					7
11.	4120.04,4120.05(A,B Cr.St.)	Gr.Surf.& Shldr.		100	97-100			30-75	15-45				6-16	8
12.	4121	Gran. Sub.	100						10-20		0-15		0-6	10
13.	4122.02 (Cr.St.)	Mac. St. Base	75mm(3") nom. max. size screen over 19mm(3/4") or 26.5mm(1.06") screen.											
14.	Deleted													
15.	Deleted													
16.	4120.07 (Cr.St.)	Pvd.Shldr.Fill	100			0-50		0-10						6
19.	4125 {13.2mm(.530") Gr. or Cr.St.}	Cover Agg.			100	97-100	40-90	0-30	0-15				0-2	
20.	4125 {13.2mm(.530")Scr.Gr.}	Cover Agg.			100	95-100	40-80	0-15	0-7				0-1.5	
21.	4125 {9.5mm(3/8")}	Cover Agg.				100	90-100	10-55	0-20	0-7			0-1.5	
22.	4127	ACC		100	98-100	85-91	65-80	45-60	25-44	10-24			3-7	11
23.	4125.01B (Cr.St.)	Slurry Tr.					100	70-90	45-70	19-34	12-25	7-18	5-15	
24.	4126, 4127 {26.5mm(1.06")}	ACC	100	92-100	77-92	60-80		34-55	20-39	7-20			2-7	3, 4
25.	4126,4127 {19mm(3/4")}	ACC		100	98-100	76-92	60-85	42-67	30-53	14-32			3-7	3, 4, 12, 15
26.	4126,4127 {26.5mm(.530")}	ACC			100	92-100	70-91	50-72	36-57	16-34			3-7	3, 4, 16
27.	4126,4127 {9.5mm(3/8")}	ACC				100	98-100	63-89	44-68	20-37			3-7	3, 4
29.	4131	Porous Backfill			100	95-100	50-100	15-50	0-8					
30.	4132.02 (Cr.St.)	Spec. Backfill	100						15-45				0-10	
31.	4132.03 (Gr.)	Spec. Backfill	Use Gradation No. 25 or No. 26 above, excluding Note 4.											
32.	4133 (Sand/Gr./Cr.St.)	Gran. Backfill	100% passing the 76.2mm(3") sieve.						20-100				0-10	9, 13
34.	4130.05 {152.4mm(6" Cr.St.)}	Erosion Stone	100% passing the 228.6mm(9") screen - 100% retained on the 76.2mm(3") sieve											

Notes: **(Gradations No. 9, 14, 15, 17, 18, and 33 have been deleted)**

1. When the fine aggregate is sieved through the following numbered sieves - 4.75mm(4), 2.36mm(8), 1.18mm(16), 600µm(30), 300µm(50), and 150µm(100) - not more than 40% shall pass one sieve and be retained on the sieve with the next higher number for 4110 and 45% for 4111.

2 and 5 deleted

3. Any operating tolerance allowed elsewhere in the specification does not apply to the largest sieve for which both a minimum and maximum are shown. The 2 percent for gradation numbers 22, 25, and 27 and the 8 percent for gradation number 24 and 26 are the tolerances for the sieve size designated.
4. The maximum amount of minus 75µm(200) sieve material for asphalt mixes shall be controlled by the filler/bitumen ratio specified for each particular class or type of mix.
6. Gradation 3 or 4 may be substituted, at the Contractor's option.
7. When compaction of material is a specification requirement, the minimum percent passing the 75µm(200) sieve is 6%.
8. See specifications for combination of gravel and limestone screenings.
9. Crushed stone shall have 100% passing the 26.5mm(1.06") sieve.
10. For granular subbase made from crushed concrete, it may be necessary to scalp or screen to attain the specified gradation. The gradation requiremen for granular subbase, not made from crushed concrete and without blending sand, shall be 10 to 30 percent passing the 2.36 mm(8) sieve.
11. Gradation 22 is used for interstate main line paving.
12. Gradation 25 is used for other than interstate main line paving.
13. When granular backfill is used under flowable mortar, one of the following alternative materials shall be used: natural sand complying with gradatio 4110, except the % passing the 75µm(200) shall not exceed 4.0%. Gravel, crushed stone, or crushed concrete meeting gradation requirement of 4121.
14. When used in precast and prestressed concrete bridge beams, 100% shall pass the 26.5mm(1.06") sieve.
15. For mixes with 50 blow Marshall mix design the following percent passing shall be used with the corresponding sieve sizes: 0.530" use 76%-95%, 3/8" use 60%-88%, No. 4 use 42%-70%, and No. 8 use 30%-56%.
16. For mixes with 50 blow Marshall mix design the following percent passing shall be used with the corresponding sieve sizes: 3/8" use 70%-94%, No. 4 use 50%-75%, and No. 8 use 36%-60%.

12-92

Wa Departmen ransportation

CERTIFIED GRADATION TEST REPORT

☐ Certified Sample
☒ Monitor Sample
☐ Verification Sample

Project WHS
Contractor
Contract No.
Design
Date 10-27-93 Report No. 3

Source Name Tegler Pit T-203A No. A28504 Source Location NE Sec. 36 Twp. 89 Range 2W 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				Other Test Results			Comp.	Tons
				—in.	26.5mm (1.06)	19mm (¾ in.)	13.2mm (0.530)	9.5mm (⅜ in.)	4.75mm (No. 4)	2.36mm (No. 8)	1.18mm (No. 16)	600µm (No. 30)	300µm (No. 50)	150µm (No. 100)	75µm (No. 200)					
*Production Limits			Max.					100	100	100		54			1.5					
			Min.						90	70					0					
10-5	DL-192-93	D.O.T.	Like					100	97	85	68	44	15	1.7	0.4					
10-5	18-93	Producer	S.L.					100	94	83	64	42	15	1.3	0.2					
10-13	DL-197-93	D.O.T.	Like					100	97	86	68	45	16	1.9	0.4					
10-13	21-93	Producer	L.M.					100	96	84	67	44	15	1.2	0.2					
10-19	DL-202-93	D.O.T.	Like					100	97	90	76	49	15	1.5	0.4					
10-20	23-93	Producer	S.L.					100	96	86	70	46	16	0.5	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 File BARD Concrete Company
Roger Boulet

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

*AGREED by the contractor/producer

ESTIMATED QUANTITY Tons
TOTAL PREVIOUSLY CERTIFIED 30000 Tons
TOTAL CERTIFIED TO DATE 42000 Tons
CERTIFICATION NUMBER 162
Reported By
Representing Iowa Department of Transportation

bution: White Copy - District Materials Engineer; Canary Copy - Project Consruction Engineer; Pink Copy - Certified Technician; Goldenrod Copy - Area Inspector

Form 821278
6-94

Iowa Department of Transportation

CERTIFIED GRADATION TEST REPORT

County Jasper
Project IM-80-5(184)160--13-5
Contractor Manatt's
Contract No.
Design
Date 7/24/95 Report No. 36

☑ 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 Sand 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 —in.	26.5mm (1.06)	19mm (¾ in.)	13.2mm (0.530)	9.5mm (⅜ in.)	4.75mm (No. 4)	2.36mm (No. 8)	1.18mm (No. 16)	Percent Passing 600µm (No. 30)	300µm (No. 50)	150µm (No. 100)	75µm (No. 200)	Other Test Results			Comp.	Tons
*Production Limits			Max.						100	100		50			1.0					
			Min.					100	90	70		10			0					
7/17/95	CC95-0258	CC	CC	Load Area				100	99	91	75	46	12	1.7	0.4					1500
7/18/95	CC95-0267	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: C. Narotam
Van Dusseldorp
Manatt's
Des Moines Lab
CC

ESTIMATED QUANTITY 3 000 Tons
TOTAL PREVIOUSLY CERTIFIED 33,750 Tons
TOTAL CERTIFIED TO DATE 36,750 Tons
CERTIFICATION NUMBER CI 906
Reported By Charlotte Cunningham

*AGREED by the contractor/producer

Distribution: Whi • Transportation Center Materials Engineer: Canary Copy • Project Construction Engineer: Pink Copy

9/96

DAILY ACC PLANT PAGE

Form E241

Project No.: NHSN-63-9(19)--2R-45
Mix Design No.: ABD6-74 R4
Mix Type: A
Page No.:
County: Howard
Contractor: Carlson Construction
Class: 1
Report No.: 12
Contract ID.: 45-0639-019
Recycle Source: None
Size: 3/4"
Design Marshall Blows: 75

Hot Box I.D. No.:		QMA-41	QMA-42	QMA-43	QMA-44	
Date Sampled:		08/02/96	08/02/96	08/02/96	08/02/96	
Target & Gradation ID:	Target	JH-13A				
1" Sieve	100	100				
3/4" Sieve	90-100	97				
1/2" Sieve	85-99	89				
3/8" Sieve	71-85	74				
* #4 Sieve	39-53	45				
Moving Average		45				
* #8 Sieve	22-32	26				
Moving Average		26				
#16 Sieve		17				
* #30 Sieve	7.0-15	11				
Moving Average		11				
#50 Sieve		4.8				
#100 Sieve		2.8				
* #200 Sieve	2.0-4.1	2.5				
Moving Average		2.7				
Compliance (Y/ N)		Y				
Intended Added, % AC	5.60					
Tank Meas., % AC		5.68				
Intended Total, % AC	5.60					
Total, % AC		5.68				
Marshall Sp. Grav.:		2.347	2.329	2.343	2.326	
Max. Sp. Grav.:		2.442	2.443	2.445	2.448	
Marshall Voids		3.9	4.7	4.2	5.0	
* Moving Avg. (N=4)	3.5-5.0	4.7	4.5	4.4	4.4	
Time		8:15	11:20	2:10	5:15	
Station		173+00	163+00	154+00	143+75	
Side		LT	LT	LT	LT	
Sample Ton		207.00	774.00	1307.00	1890.00	
Sublot Tons		500.00	533.33	533.33	550.88	
Tons to Date		25773.64	26306.97	26840.30	27391.18	
Fines / Bitumen Ratio	0.3-1.20	0.44				
QUALITY CONTROL ACTIONS: 1.) AC Changes 2.) Cold Feed Adjust. 3.) Moisture Adjust. 4.) Etc.		2				

Time	7:00	9:00	11:00	1:00	3:00	5:00	7:00
Air Temp. (°F)	61	72	79	82	84	84	
A.C. Temp. (°F)	300	300	300	300	300	300	
Mix Temp. (°F)	280	284	280	288	282	284	

Date Placed: 08/02/96
Date Tested: 08/03/96

Course Placed: Binder
Tested By: Jay Haas

Density Record

Core No.:	1	2	3	4	5	6	7
Station	139+89	144+32	148+63	153+62	161+90	167+58	174+20
CL Reference	1.5' LT	2.0' LT	8.5' LT	10.0' LT	2.0' LT	6.5' LT	9.0' LT
W 1 Dry	827.8	831.1	822.8	827.0	810.9	858.0	818.9
W 2 in H20	465.0	466.8	460.2	463.9	458.3	483.3	464.7
W 3 Wet	829.0	832.8	823.9	828.2	811.8	858.8	819.7
Difference	364.0	366.0	363.7	364.3	353.5	375.5	355.0
Field Density	2.274	2.271	2.262	2.270	2.294	2.285	2.307
% Density	97.346	97.217	96.832	97.175	98.202	97.817	98.759
% Voids	7.0	7.1	7.5	7.2	6.2	6.5	5.6
Thickness	2.00	2.12	2.00	2.00	1.87	2.25	2.00

Avg. % Field Voids: 6.7
Avg. Field Density: 2.280
Marshall Sp. G (Lot Avg.): 2.336
Avg. % Density: 97.621
Max. Sp. G (Lot Avg.): 2.445
Specified Density %: 95

Q.I. = $\frac{97.621 - 95}{0.675} = 3.88$

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

Film Thickness (FT): 15.1
VMA: 13.2

Remarks: A 3% aggregate proportion change was made before plant production started today.

C.P.I.: Jay Haas
NE-208 Cert. No.
QMA Tech: Al Forde
NE-118 Cert. No.

9/96

DAILY ACC PLANT PAGE

Form M241

Project No.: NHSN-63-9(19)--2R-45
Mix Design No.: ABD6-74 R5
Mix Type: A
Page No.:

County: Howard
Contractor: Fred Carlson Construction
Class:
Report No.: 14

Contract ID.: 45-0639-019
Recycle Source: None
Size 19 mm
Design Marshall Blows: 75

Hot Box I.D. No.:		QMA-48	QMA-49	QMA-50	QMA-51	
Date Sampled:		08/06/96	08/06/96	08/06/96	08/06/96	
Target & Gradation ID:	Target	JH-15A	JH-15B	JH-15C	AVG.	
26.5mm Sieve	100	100	100	100	100	
19mm Sieve	90-100	99	99	100	99	
13.2mm Sieve	86-100	96	92	93	94	
9.5mm Sieve	73-87	85	79	78	81	
* 4.75mm Sieve	41-55	56	52	49	52	
Moving Average		48	50	52		
* 2.36mm Sieve	24-34	34	32	32	33	
Moving Average		28	30	32		
1.18mm Sieve		21	21	22	21	
* 600um Sieve	9.0-17	14	14	15	14	
Moving Average		12	13	14		
300um Sieve		6.0	7.0	7.2	6.7	
150um Sieve		3.8	4.4	4.1	4.1	
* 75um Sieve	3.0-5.5	3.5	4.0	3.7	3.7	
Moving Average		3.7	3.8	3.7		
Compliance (Y/N)		N	Y	Y	Y	
Intended Added, % AC	5.60					
Tank Meas., % AC		5.63				
Intended Total, % AC	5.60					
Total, % AC		5.63			5.63	
Marshall Sp. Grav.:		2.332	2.325	2.334	2.342	
Max. Sp. Grav.:		2.432	2.446	2.439	2.437	
Marshall Voids		4.1	4.9	4.3	3.9	
Moving Avg. (N=4)	3.5-5.0	4.6	4.6	4.4	4.3	
Time		09:30	12:00	02:45	05:00	
Station		127+25	115+00	107+50	97+75	
Side		LT	LT	LT	LT	
Sample Mg		420.00	1018.00	1429.00	1975.00	
Sublot Mg		500.00	633.33	633.33	540.66	
Mg to Date		500.00	1133.33	1766.66	2307.32	
Fines / Bitumen Ratio	0.3-1.20	0.62			0.66	
QUALITY CONTROL ACTIONS: 1.) AC Changes 2.) Cold Feed Adjust. 3.) Moisture Adjust.		2				

Time	7:00	9:00	11:00	1:00	3:00	5:00	7:00
Air Temp. (°C)	22	25	28	31	32	32	
A.C. Temp. (°C)	149	149	149	149	149	149	
Mix Temp. (°C)	140	138	138	141	140	140	

Date Placed: 08/06/96
Date Tested: 08/07/96

Course Placed: Binder
Tested By: Jay Haas

Density Record

Core No.:	1	2	3	4	5	6	7
Station	91+28	100+39	102+20	113+2	116+16	128+50	133+10
CL Reference	2.9 LT	2.0 LT	2.7 LT	0.5 LT	1.6 LT	2.8 LT	0.7 LT
W 1 Dry	754.2	860.0	860.9	906.2	840.2	855.4	907.8
W 2 in H20	422.9	483.3	537.1	506.9	473.6	482.5	511.0
W 3 Wet	755.0	860.9	962.6	907.4	841.3	856.3	908.5
Difference	332.1	377.6	425.5	400.5	367.7	373.8	397.5
Field Density	2.271	2.278	2.023	2.263	2.285	2.288	2.284
% Density	97.342	97.643	86.712	97.000	97.943	98.071	97.900
% Voids	6.9	6.6	17.1	7.2	6.3	6.2	6.4
Thickness (mm)	50	55	62	57	51	53	56

Avg. % Field Voids: 6.7
Avg. Field Density: 2.275
Marshall Sp. G (Lot Avg.): 2.333
Avg. % Density: 97.526
Max. Sp. G (Lot Avg.): 2.439
Specified Density: 95

$$\text{Q.I.} = \frac{97.526 \; — \; 95.000}{0.497} = \underline{5.08}$$

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

Film Thickness (FT): 11.2
VMA: 13.2

Remarks: A 2 % aggregate proportion change was made at 8:22 am. with 312.54 Mg. mix produced. Gradations reflect new specifications.

C.P.I.: Jay Haas
NE-208 Cert. No.

DAILY ACC PLANT PAGE

Form M241

Project No.: NHSN-63-9(19)--2R-45
Mix Design No.: ABD6-56
Mix Type: A
Page No.:

County: Howard
Contractor: Mathy Construction
Class:
Report No.: 14

Contract ID.: 45-0639-019
Recycle Source: None
Size 19 mm
Design Marshall Blows: 75

Hot Box I.D. No.:		HB-14				
Date Sampled:		08/06/96				
Target & Gradation ID:	Target	DS-3A	DS-3B	DS-3C	AVG.	
26.5mm Sieve	100	100	100	100	100	
19mm Sieve	90-100	99	99	100	99	
13.2mm Sieve	86-100	96	92	93	94	
9.5mm Sieve	73-87	85	79	78	81	
* 4.75mm Sieve	41-55	56	52	49	52	
Moving Average						
* 2.36mm Sieve	24-34	34	32	32	33	
Moving Average						
1.18mm Sieve		21	21	22	21	
* 600um Sieve	9.0-17	14	14	15	14	
Moving Average						
300um Sieve		6.0	7.0	7.2	6.7	
150um Sieve		3.8	4.4	4.1	4.1	
* 75um Sieve	3.0-5.5	3.5	4.0	3.7	3.7	
Moving Average						
Compliance (Y/N)		N	Y	Y	Y	
Intended Added, % AC	5.60					
Tank Meas., % AC		5.63				
Intended Total, % AC	5.60					
Total, % AC		5.63			5.63	
Marshall Sp. Grav.:		2.333				
Max. Sp. Grav.:		2.439				
Marshall Voids		4.1				
Moving Avg. (N=4)	3.5-6.0					
Time						
Station						
Side						
Sample Mg						
Sublot Mg						
Mg to Date						
Fines / Bitumen Ratio	0.3-1.20	0.62			0.66	
QUALITY CONTROL ACTIONS: 1.) AC Changes 2.) Cold Feed Adjust. 3.) Moisture Adjust. 4.) Etc.						

Time	7:00	9:00	11:00	1:00	3:00	5:00	7:00
Air Temp. (°C)	22	25	28	31	32	32	
A.C. Temp. (°C)	149	149	149	149	149	149	
Mix Temp. (°C)	140	138	138	141	140	140	

Date Placed: 08/06/96
Date Tested: 08/07/96

Course Placed: Binder
Tested By: Jay Haas

Density Record

Core No.:	1	2	3	4	5	6	7
Station	91+28	100+39	102+20	113+2	116+16	128+50	133+10
CL Reference	2.9 LT	2.0 LT	2.7 LT	0.5 LT	1.6 LT	2.8 LT	0.7 LT
W 1 Dry	754.2	860.0	860.9	906.2	840.2	855.4	907.8
W 2 in H20	422.9	483.3	537.1	506.9	473.6	482.5	511.0
W 3 Wet	755.0	860.9	962.6	907.4	841.3	856.3	908.5
Difference	332.1	377.6	425.5	400.5	367.7	373.8	397.5
Field Density	2.271	2.278	2.023	2.263	2.285	2.288	2.284
% Density	97.342	97.643	86.712	97.000	97.943	98.071	97.900
% Voids	6.9	6.6	17.1	7.2	6.3	6.2	6.4
Thickness (mm)	50	55	62	57	51	53	56

Avg. % Field Voids: 6.7
Avg. Field Density: 2.275
Marshall Sp. G (Lot Avg.): 2.333
Avg. % Density: 97.526
Max. Sp. G (Lot Avg.): 2.439
Specified Density: 95

Q.I. = $\frac{97.526 - 95.000}{0.497}$ = 5.08

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

Film Thickness (FT):
VMA:

Remarks: Example of Non QMA project.

C.P.I.: Jay Haas
NE-208 Cert. No.
QMA Tech: Al Forde
NE-118 Cert. No.

9/96

PCC Plant Page

Form E240

Page: ________

Project No.: STPN-3-6(29)--2J-09
Plant Name: Croell - Waverly
Contractor / Sub: PCI / CFI
Contract ID.: 09-0036-029

County: Bremer
Weather: Sunny - Cool
Min. Temp. (°F): 65
Max. Temp. (°F): 75

Report No.: 1
Date This Report: 08/31/96
Date Of Last Report: 08/30/96
Design No.:

Check One (x)		Check One (x)		
Central Mix		Paving	x	(Send Daily or End of Lot)
Ready Mix	x	Structure		(Send Weekly or End of Lot)
Mobile Mix				(Send Weekly or End of Lot)

Year 1996 Date	Mix Number	Time Start	Time Stop	Batched (CY)	% of Est. Used	Fine Aggregate Moist. (%)	Fine Aggregate T-203 Sp. G.	Fine Aggregate Dry Wt. (lbs)	Coarse Aggregate Moist. (%)	Coarse Aggregate T-203 Sp. G.	Coarse Aggregate Dry Wt. (lbs)	Cement	Fly Ash	Fine	Coarse	Water In Agg.	Water Plant	Water Grade	Avg. W/C Ratio	Max. W/C Ratio
08/31	C4WRC20	07:26	02:49	506.00	101.2	2.6	2.66	1510.0	0.2	2.65	1500.0	474.0	119.0	1550.0	1503.0	43.0	207.0	3.0	0.427	.489

Actual Quantities Used Per CY (in pounds)

C O A R S E S A M P L E

Sieve Accuracy= 99.8% | Sieve Accuracy= | Sieve Accuracy=
Orig. Dry Weight (OD Wt.): 6924.2 | Orig. Dry Weight (OD Wt.): | Orig. Dry Weight (OD Wt.):
Dry Wt. Washed (D Wt. W): | Dry Wt. Washed (D Wt. W): | Dry Wt. Washed (D Wt. W):

Sieve Size	Wt. Retd.	% Retd.	% Retd.	% Psg.	Wt. Retd.	% Retd.	% Retd.	% Psg.	Wt. Retd.	% Retd.	% Retd.	% Psg.	Specs.	Avg.
1 1/2 "				100.0									100	
1 "				100.0									95-100	
3/4 "	1731.4	25.0		75.0										
1/2 "	1710.0	24.7		50.3									25-60	
3/8 "	1796.9	26.1		24.2										
#4	1251.2	18.1		6.1									0-10	
#8	·317.4	4.6		1.5									0-5	
Pan	103.8	1.5												
Total	6910.7	100.0												
#200				0.9									0-1.5	

W a s h

Wash Loss	15.3	OD Wt.:	3020.6		OD Wt.:		OD Wt.:
Pan	10.5	D Wt. W.:	3005.3		D Wt. W.:		D Wt. W.:
Total	25.8						

Check One (x):	Today	Week	Total
	x		
Concrete Batched(CY)	506.00		506.00
Cement Batched(Tons)	119.65		119.65

	Brand / Source	Rate	Lot No.
Air Entrain:	DV 1000		CF06-183-22
Wat. Red:	WRDA82	4.0	CF05-A178-40
Retarder:			
Cal. Chlor:			
Superplas:			

Concrete Treatment (x)		lbs / CY
Ice		
Heated Water		
Heated Materials		

F I N E S A M P L E

Sieve Accuracy= 100.0% | Sieve Accuracy= | Sieve Accuracy=
Orig. Dry Weight: 617.3 | Orig. Dry Weight: | Orig. Dry Weight:
Dry Wt. Washed: 615.7 | Dry Wt. Washed: | Dry Wt. Washed:
Washing Loss: 1.6 | Washing Loss: | Washing Loss:

Sieve Size	Wt. Retd.	% Retained	% Retained Final	% Passing	Wt. Retd.	% Retained	% Retained Final	% Passing	Wt. Retd.	% Retained	% Retained Final	% Passing	Specs.	Avg.
3/8 "				100.0									100	
#4	13.7	2.2		97.8									90-100	
#8	50.7	8.2		89.6									70-100	
#16	109.5	17.7		71.9										
#30	172.4	27.9		44.0									10-60	
#50	197.0	32.0		12.0										
#100	66.8	10.8		1.2										
#200	5.2	0.8		0.4									0-1.5	
Wash	1.6	0.4												
Pan	0.7													
Total	617.6	100.0												
Less + #4														

Date Reported (DR):	08/31/96	(DR):		(DR):	
Tested By/Date (TB/D):	Bill Croell NE-463	(TB/D):		(TB/D):	

Mobile Mixer	
Cement Meter	Water Meter

Remarks

C.P.I.: Bill Croell — Cert. No. NE-463

9/96

PCC Plant Page

Form M240

Page: ________

Project No.: NHSN-63-9(19)--2R-45
Plant Name: Croell R/M - Elma
Contractor / Sub: Wicks Construction - Sub
Contract ID.: 45-0639-019

County: Howard
Weather: ________
Min. Temp. (°C): ________
Max. Temp. (°C): ________

Report No.: 6
Date This Report: 07/13/96
Date Of Last Report: 07/06/96
Design No.: 748

Check One (x)		Check One (x)		
Central Mix		Paving	x	(Send Daily or End of Lot)
Ready Mix	x	Structure	x	(Send Weekly or End of Lot)
Mobile Mix				(Send Weekly or End of Lot)

Year 1996 Date	Mix Number	Time		Batched (m3)	% of Est. Used	Fine Aggregate			Coarse Aggregate			Actual Quantities Used Per m3 (in kilograms)							Avg. W/C Ratio	Max. W/C Ratio
		Start	Stop			Moist. (%)	T-203 Sp. G.	Dry Wt. (kg)	Moist. (%)	T-203 Sp. G.	Dry Wt. (kg)	Cement	Fly Ash	Fine	Coarse	Water In Agg.	Water Plant	Water Grade		
07/09	D-57			5.73	101.1	3.6	2.65	832.0	0.4	2.54	798.0	421.0		863.0	801.0	34.0	149.0	1.0	0.437	0.450
07/10	M-4			1.91	100.0	3.6	2.65	827.0	0.4	2.54	790.0	490.0		858.0	793.0	34.0	147.0	1.0	0.371	
07/12	C-4			50.84	100.7	3.6	2.65	877.0	0.7	2.54	843.0	371.0		910.0	849.0	39.0	131.0		0.458	0.488

C		Sieve Accuracy= 100.0%				Sieve Accuracy=				Sieve Accuracy=					
O		Orig. Dry Weight (OD Wt.):			6808.7	Orig. Dry Weight (OD Wt.):				Orig. Dry Weight (OD Wt.):					
A		Dry Wt. Washed (D Wt. W):				Dry Wt. Washed (D Wt. W):				Dry Wt. Washed (D Wt. W):					
R	Sieve Size	Wt. Retd.	% Retd.	% Retd.	% Psg.	Wt. Retd.	% Retd.	% Retd.	% Psg.	Wt. Retd.	% Retd.	% Retd.	% Psg.	Specs.	Avg.
S	37.5mm				100.0									100	
E	26.5mm	26.1	0.4		99.6									95-100	
	19mm	1656.2	24.3		75.3										
S	13.2mm	2463.0	36.2		39.1									25-60	
A	9.5mm	1637.4	24.0		15.1										
M	4.75mm	999.8	14.7		0.4									0-10	
P	2.36mm	22.4	0.3		0.1									0-5	
L	Pan	5.0	0.1												
E	Total	6809.9	100.0												
W	75um				0.6									0-1.5	
a	Wash Loss	18.9	OD Wt.:	3294.4			OD Wt.:				OD Wt.:				
s	Pan	2.4	D Wt. W.:	3275.5			D Wt. W.:				D Wt. W.:				
h	Total	21.3													

		Sieve Accuracy= 100.0%				Sieve Accuracy=				Sieve Accuracy=					
			Orig. Dry Weight:		637.8		Orig. Dry Weight:				Orig. Dry Weight:				
			Dry Wt. Washed:		633.9		Dry Wt. Washed:				Dry Wt. Washed:				
			Washing Loss:		3.9		Washing Loss:				Washing Loss:				
		Wt.	% Retained		%	Wt.	% Retained		%	Wt.	% Retained		%		
F	Sieve Size	Retd.		Final	Passing	Retd.		Final	Passing	Retd.		Final	Passing	Specs.	Avg.
I	9.5mm				100.0									100	
N	4.75mm	29.1	4.6		95.4									90-100	
E	2.36mm	55.1	8.6		86.8									70-100	
	1.18mm	85.1	13.3		73.5										
S	600um	144.6	22.7		50.8									10-60	
A	300um	225.2	35.4		15.4										
M	150um	87.8	13.8		1.6										
P	75um	6.0	0.9		0.7									0-1.5	
L	Wash	3.9	0.7												
E	Pan	0.8													
	Total	637.6	100.0												
	Date Reported (DR):	07/09/96				(DR):				(DR):					
	Tested By/Date (TB/D):	Doug Kronneman			NE-386	(TB/D):				(TB/D):					

	Today	Week	Total
Check One (x):		x	Total
Concrete Batched(m3)		58.48	732.63
Cement Batched(Mg)		22.21	343.56

	Brand / Source	Rate	Lot No.
Air Entrain:	DV 1000 - WR Grace		CF03 A183-8
Wat. Red:			
Retarder:			
Cal. Chlor:			
Superplas:			

Concrete Treatment (x)		kg / m3
Ice		
Heated Water		
Heated Materials		

Mobile Mixer	
Cement Meter	Water Meter

Remarks

C-4 mix was used for bridge approaches.

D-57 mix was used for barrier rails.

		Cert. No.
C.P.I.:	Doug Kronneman	795
Monitor:	Danny Steenhard	NE-386

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