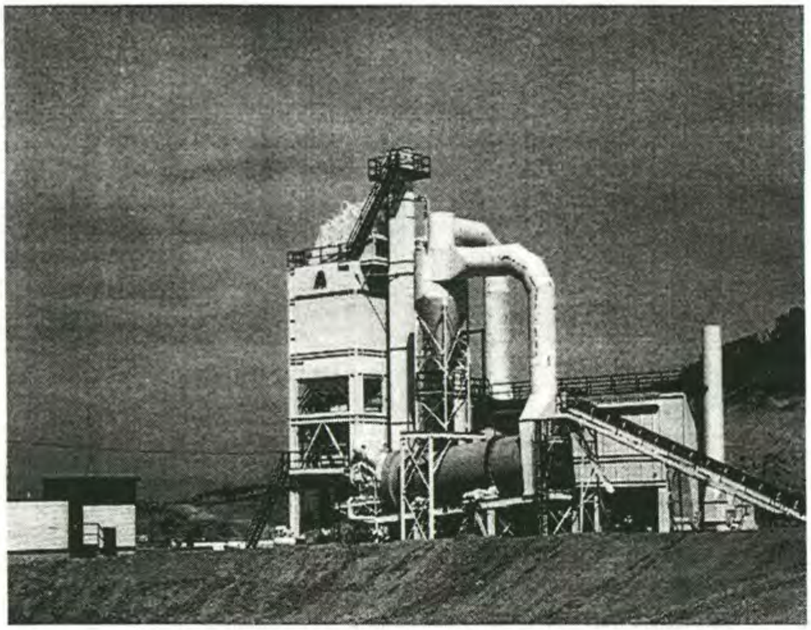
LEVEL I
HOT MIX ASPHALT

2001 - 2002



TECHNICAL TRAINING &
CERTIFICATION PROGRAM

Iowa Department
of Transportation
HIGHWAY DIVISON

HOT MIX ASPHALT INSTRUCTION MANUAL

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Technician Duties

This course is intended for training of certified inspectors. It will acquaint you with the basics of hot mix asphalt (HMA) plants and related inspection duties.

You will be studying these items during the course. Since we are emphasizing plant production Quality Control, the last two (placing and compaction) will be only briefly covered.

The basic project relationship involves an owner who wants work done to fill a need and is willing to pay for it and a contractor who agrees to perform that work to certain standards for an agreed price. In the case of government agencies, the owner is the public.

Since the owner (public) cannot personally watch the work being done to be sure the standards are met, there enters the third party, the certified technician.

From I.M. 213-The certified technician is to assure quality control, procedures, and test results for use by the owner.

When the contract is signed, the contractor has agreed to perform the work according to the plans and specifications. It is the certified technician's job to document that the hot mix asphalt is properly produced. They are to advise the engineer (owner) of what is happening at the HMA plant and to immediately call to the project engineer's and the contractor's attention any deviation from the specification requirements.

The certified technician does not have the authority to modify the plans or specifications to accept the work or to act as any part of the contractor's regular production chain.

The field testing manuals are the instructions on how to perform the various required tests. This manual is the Field Sampling and Testing section in Volume II of Materials I.M.'s.

It lists: 1) what the tests are for; 2) the equipment needed; 3) how to obtain and prepare the sample; 4) the test procedure; and 5) calculation required to compute the results.

In addition, the certified technician should have their asphalt plant manual. This manual is the AC concrete section of Volume II of the Materials I.M.'s. This manual lists the requirements for plant inspection and mixture Quality Control, and provides, the table and charts needed to do their daily inspection.

You should also have a copy of the Aggregate Source Manual (T-203). This is located in Volume IV of Materials I.M.'s. This book lists the aggregate sources that have been sampled and tested by the Iowa DOT. The listing gives frictional classification for asphalt aggregate and durability class for portland cement concrete.

Let's not forget the Construction Manual. These are the guidelines developed by the Iowa DOT for interpreting and using the specifications. Chapter 8 is the section on asphalt and Chapter 2 lists the recommended price adjustments for non-complying material tests. Chapter 3 has general inspection requirements, portions of which are included in your manual.

Even under the best circumstances, confusion and error can result if you are not sure of your information. Take time to properly prepare for the job. Study your plans and specifications. If you don't understand them, **ASK.**

If the qualifications for a good technician were put all together, the summary would look like this. If a technician is not honest in all areas of work, the others mean nothing. A good plant technician can save the contractor from costly price adjustments and at the same time provide a better quality road system for the traveling public. One point that cannot be overemphasized and will be mentioned many times during this course is safety. It should be the business of everyone on the job. Each plant

Qualifications of a Good Technician

- Knowledge
- Common Sense
- Observation
- Honesty

site and piece of equipment is different. You must be concerned with safety at all times. If you see a dangerous situation, you are obligated to tell the contractor about it. If there is eminent danger, the contractor can be shut down.

A properly equipped plant will have good safety features. Steps, railings, ladder enclosures, and clear work areas should be required at all plants. The time to worry about accidents is before they happen.

Part of the certified technician's job is to monitor mix temperature. A technician was seriously injured when his foot slipped, causing him to fall. There is no good excuse for putting yourself into hazardous situations.

Safety First!

If you are one of those people who dive in before checking the water depth, please change your attitude about safety when you are working on a project. Don't jump into anything until you know what you are getting yourself into.

Wear the protective equipment you need to do the job safely. If you have a problem, talk to your supervisor immediately.

Substantiating documents, such as truck weight tickets, are used to verify pay quantity records. Tickets for documentation may be needed for such items as asphalt binder, hot mix asphalt mixture, shoulder aggregate, and other items. You must know what documentation records are required before the job starts.

A good certified technician has a combination of attitude and qualifications that boil down to wanting to do the best job possible, knowing how to do high quality work, and then going out and doing it every day.

Get to know your plant. Become as familiar with it as you can.

A Good Technician

- Wants to do the job
- Knows how to do it
- Does it again

Plant controls are an important start to quality control. Improper settings can help produce an inferior product. Make sure the settings are correct and you know what they mean.

Don't sit in your lab all day. Get out and observe all plant functions.

Stockpiles should be prepared correctly. They should be free of contamination and worked properly.

Cold feed samples are another important item in quality control. Proper sampling and testing are essential to the final outcome of the asphalt product.

ASPHALT SPECIFICATIONS

ASPHALT BINDER (AC)
AASHTO MP1
Combined State Binder Group Document
Specification 4137

MIXTURE
SS-01001 (Marshall Mix Design)
SS-01002 (Gyratory Mix Design for Local Systems)
SS-01011 (Gyratory Mix Design)
Specification 2303 (Hot Mix Asphalt Mixtures)
AASHTO MP2 (Superpave Volumetric Properties)

EQUIPMENT
Specification 2001
Test equipment is specified in each test method.

AGGREGATE
Specification 4126 (Type B)
Specification 4127 (Type A)
AASHTO MP2 (Gradation Control Points)

EMULSION
Specification 4140
AASHTO M 140
AASHTO M 208

CUT-BACK ASPHALT
Specification 4138
AASHTO M 81
AASHTO M 82

Aggregate at the Plant

There are several specification requirements for the aggregates that are used in the HMA mixes. Quality requirements include freeze/thaw tests, abrasion tests, shale limits, clay limits, and absorption limits. Aggregates also have gradation limits and angularity requirements to follow. As a technician, you should know about these specifications and whether the materials comply.

Crushed limestone for HMA is produced at a limestone quarry or it can be obtained from an underground limestone mine.

The raw materials can then be processed, crushed, and sized. The initial gradation control of the aggregates begins as it is being produced.

Gravel aggregates that are used in HMA mixes can vary from pit run gravel, to crushed, oversized gravel, to washed sand. The material used will vary according to mix requirements and the type of mix to be used.

Another material used in HMA mixes is recycled asphalt pavement or RAP. This is a milled material that is removed and sized prior to being used in a new asphalt mix. The millings will be tested for gradation and percent of binder in the RAP prior to use. The District Materials Office will Either do this or give information on proper procedures.

A technician's job begins when the plant site is set up and delivery of material starts. You have been given general information about mixes and plants.

There are three problems that can occur at a plant that can have a bearing on the aggregate. These are segregation, degradation, and contamination. Quite often aggregate segregation and contamination occur after the material arrives at the plant site. Aggregate segregation causes variable HMA mix gradation results. When a material is stockpiled by a conveyor stacker building conical stockpiles over tunnel cold feed belt, the cold feed opening is directly beneath the center of the cone. When a material is stockpiled by this method, the center of the cone is generally fine and the coarse aggregate rolls down the outside of the pile. As the material is fed out of the stockpile, there will likely be variation in the gradation. The feed will start out fine and get coarser as the pile is used. This variability is aggregate segregation.

Stockpiling/Handling Concerns

- Segregation
- Degradation
- Contamination

Truck dumping is a common method of building a stockpile. Sometimes the stockpile is built in layers, with the trucks backing up onto the pile to make new lifts. Degradation may occur if that happens. End loaders may be used to lift the material into a higher pile.

Another method of stockpiling is with a stacker. A good technique is a movable stacker, which puts the stockpile in lifts. There is generally very little segregation, good base, and overall good control of the material.

The opposite type of operation is to set the stacker too high so that the material segregates. In fact, the specifications require that recycled asphalt paving stockpiles be constructed in layers 4 feet (1.2 m) in height.

Stockpiling can be done with a clam bucket on a dragline. This gives good control of the operation, but the operator should use care not to get too high too soon.

Using a dozer is not recommended as a method of building a stockpile, especially if the material is prone to degradation. When a dozer is used to stockpile, it forms a ramp area that is used over and over. The aggregate forming the ramp is ground up under the dozer tracks, causing breakdown. That is why the recycle specifications prohibit the dozer from operating on the stockpile. Degradation of the aggregate in the stockpile can be a source of gradation problems in the mix.

There is less chance of segregation if the aggregate stockpile is constructed with a lower profile and an end loader is used to change the tunnel cold feed. Using the end loader tends to equalize the feed of the coarse and fine areas of the stockpile.

When possible, it is best to work along the vertical face of a stockpile when charging the cold feed bins. This tends to minimize segregation problems, giving us less variation in the final mix gradation.

Proper calibration of the cold feed will provide the proper belt speed and gate opening for uniform delivery of each aggregate. If you have non-uniform feed, it is doubtful that you will get a representative sample of the materials in the mix.

Aggregate contamination goes hand in hand with segregation. Careless dumping of material into a wrong stockpile contaminates good material. Contamination effects gradation results in the final mix.

A good technician is alert to all types of contamination. This may appear as only minor contamination of dirt in the base of the stockpile, but signals careless habits that develop. Don't allow this to continue.

As stockpile bases get softer, there is a greater danger that chunks of mud or dirt contaminate the aggregate. Not only do these chunks contaminate the mix, they also tend to plug the throat of the cold feed gate. This really fouls up gradation results.

The last source of aggregate contamination is the cold feed bins themselves. Sometimes bin dividers are not high enough to prevent material from overflowing from one bin to another when slightly overfilled.

Aggregate is accepted for use on the basis of the certified aggregate program, described in Materials I.M. 409. The certified technician is responsible to see that proper certification is done. One method is the certified aggregate scale ticket, used when material is brought to the plant site. The contractor must keep these on file at the plant, and the inspector checks the file periodically for quantity and compliance.

If the plant is located at the pit or quarry where the aggregate is produced, there will not be truck delivery tickets. In this case, the producer may use a gradation report form to certify the material to the project. The contractor keeps the reports on file at the plant, and the technician checks for compliance.

The technician should be documenting in the plant books that the aggregate reports have been reviewed, the source identified and record the quantity involved.

Specific Gravity

Density

- Definition
  - mass of a unit volume of material
  - units of pcf or g/cm^3
- "Bulk Density"
  - contains several materials

Specific Gravity

- **Definition**
  - **ratio of mass/volume (density) of object to mass/volume (density) of water at the same temperature**
  - **unitless (units cancel)**
  - **essentially, how many times heavier or lighter than water is the object**
- **Used as Bridge Between Mass and Volume of Objects**

Specific Gravity

$$G = \frac{mass\ (object)\ /\ volume\ (object)}{mass\ (water)\ /\ volume\ (water)}$$

Or,

$$G = \frac{density(object)}{density(water)}$$

Density of Water

- **In the metric system, the density of water (at standard temperature of 25°C) is:**
  - **$1\ g/cm^3 = 1000\ kg/m^3$**
- **In English units, the density of water is 62.4 pcf.**
- ***For ease, use metric.***

Specific Gravity

So, in the metric system,

$$G = \frac{density(object)}{1.000\ g\ /\ cm^3}$$

Or,

$$G = \frac{mass/volume}{1.000 g\ /\ cm^3}$$

Specific Gravity

- Relates Density

$$D = G \times 1.000$$

Density in g/cm³ (D); sp grav of object (G); approx density of water in g/cm³ at 25 C (1.000)

Specific Gravity

- Relates Volume

$$V = \frac{M}{G \times 1.000}$$

volume of object (V); mass of object (M); sp grav of object (G); density of water at 25 C (1.000)

Specific Gravity

- Relates Volume (example)

$$\text{Volume} = \frac{75 \text{ kg x } 1000 \text{ g/kg}}{2.500 \text{ x } 1.000 \text{ g/cm}^3} =$$

Types of Specific Gravity

- Specific Gravity of Binder (1.00 to 1.05)
- Specific Gravity of Aggregate
- Specific Gravity of Mix

Convention

- Symbols for Specific Gravity show material and type of specific gravity.

G_{mb}

Material
m=mix
s=stone
b=binder

Type of SG
a=apparent
b=bulk
e=effective
m=maximum

Aggregate Specific Gravity

- **Aggregate Bulk (G_{sb})** - *measured*
  - dry weight and bulk volume
- **Aggregate Effective (G_{se})** - *calculated*
  - dry weight and effective volume
  - excludes absorbed asphalt volume
- **Aggregate Apparent (G_{sa})** - *measured*
  - dry weight and apparent volume
  - excludes absorbed water volume

Aggregate Consensus Properties

It was the consensus of the pavement experts that worked on SHRP that certain aggregate characteristics were critical and needed to be achieved in all cases to arrive at well performing HMA. These characteristics were called "consensus properties" because there was wide agreement in their use and specified values. Those properties are:

- **coarse aggregate angularity,**
- **fine aggregate angularity,**
- **flat, elongated particles, and**
- **clay content**

There are required standards for these aggregate properties. The consensus standards are not uniform. They are based on traffic level and position within the pavement structure. Materials near the pavement surface subjected to high traffic levels require more stringent consensus standards. They are intended to be applied to a proposed aggregate blend rather than individual components. However, many agencies currently apply such requirements to individual aggregates so that undesirable components can be identified.

Coarse Aggregate Angularity

This property ensures a high degree of aggregate internal friction and rutting resistance. It is defined as the percent by weight of aggregates larger than 4.75 mm with one or more fractured faces.

The test method used is ASTM D5821 "Standard Test Method for Determining the percentage of fractured particles in coarse aggregate." This test involves manually counting particles to determine fractured faces. A fractured face is defined as any fractured surface that occupies more than 25 percent of the area of outline of the aggregate particle visible in that orientation.

Iowa does not use this test because of its subjective nature. Iowa specifies a percent crushed and a method for crushing gravel that assures two crushed faces.

Fine Aggregate Angularity

This property ensures a high degree of fine aggregate internal friction and rutting resistance. It is defined as the percent air voids present in loosely compacted aggregates smaller than 2.36 mm. Higher void contents mean more fractured faces.

The test procedure used to measure this property is AASHTO T304, "Uncompacted Void content of Fine Aggregate" using Method A. In the test, a sample of fine aggregate is poured into a small calibrated cylinder by flowing through a standard funnel.

By determining the weight of fine aggregate (W) in the filled cylinder of known volume (V), void content can be calculated as the difference between the cylinder volume and fine aggregate volume collected in the cylinder. The fine aggregate bulk specific gravity (G_{sb}) is used to compute fine aggregate volume.

Table 1 outlines the required minimum values for fine aggregate angularity as a function of traffic level and position within pavement.

Table 1. Iowa Gyratory fine Aggregate Angularity Requirements

Traffic, million ESALs	Depth from Surface	
	<100 mm	>100 mm
<0.3	-	-
<1	40	-
<3	40	40
<10	43	40
<30	45	40
<100	45	43
≥100	45	45
Note: Criteria are presented as percent air voids in loosely compacted fine aggregate.		

Flat, Elongated Particles

This characteristic is the percentage by weight of coarse aggregates that have a maximum to minimum dimension of greater than five. Elongated particles are undesirable because they have a tendency to break during construction and under traffic. The test procedure used is ASTM D 4791, "Flat or Elongated Particles in Coarse Aggregate" and it is performed on coarse aggregate larger than 4.75 mm.

The procedure uses a proportional caliper device to measure the dimensional ratio of a representative sample of aggregate particles. In this test, the aggregate particle is first placed with its largest dimension between the swinging arm and fixed post at position A. The swinging arm then remains stationary while the aggregate is placed between the swinging arm and fixed post at position B. If the aggregate passes through this gap, then it is counted as a flat and elongated particle.

Table 2 outlines the required maximum values for flat and elongated particles in coarse aggregate.

Table 2. Gyratory Flat, Elongated Particle Requirements

Traffic, million ESALs	Percent
<0.3	-
<1	-
<3	10
<10	10
<30	10
<100	10
≥100	10
Note: Criteria are presented as maximum percent by weight of flat and elongated particles.	

Clay Content

Clay content is the percentage of clay material contained in the aggregate fraction that is finer than a 4.75 mm sieve. It is measured by AASHTO T 176, "Plastic Fines in Graded Aggregates and Soils by Use of the Sand Equivalent Test."

In this test, a sample of fine aggregate is placed in a graduated cylinder with a flocculating solution and agitated to loosen clayey fines present in and coating the aggregate. The flocculating solution forces the clayey material into suspension above the granular aggregate. After a period that allows sedimentation, the cylinder height of suspended clay and sedimented sand is measured. The sand equivalent value is computed as a ratio of the sand to clay height readings expressed as a percentage.

Table 3 outlines the required clay content values for fine aggregate.

Table 3. Gyratory Clay Content Requirements

Traffic, million ESALs	Sand Equivalent, minimum
<0.3	40
<1	40
<3	40
<10	45
<30	45
<100	50
≥100	50

Source Properties

In addition to the consensus aggregate properties, pavement experts believed that certain other aggregate characteristics were critical. However, critical values of these properties could not be reached by consensus because needed values were source specific. Consequently, a set of "source properties" was recommended. Specified values are established by local agencies. While these properties are relevant during the mix design process, they may also be used as source acceptance control. Those properties are:

- **toughness,**
- **soundness, and**

- **deleterious materials.**

Toughness

Toughness is the percent loss of materials from an aggregate blend during the Los Angeles Abrasion test. The procedure is stated in AASHTO T 96, "Resistance to Abrasion of Small Size Coarse Aggregate by Use of the Los Angeles Machine." This test estimates the resistance of coarse aggregate to abrasion and mechanical degradation during handling, construction, and in-service. It is performed by subjecting the coarse aggregate, usually larger than 2.36 mm, to impact and grinding by steel spheres. The test result is percent loss, which is the weight percentage of coarse material lost during the test as a result of the mechanical degradation. Maximum loss values in Iowa are specified at 45 percent.

Soundness

Soundness is the percent loss of materials from an aggregate blend during the sodium or magnesium sulfate soundness test. The procedure is stated in AASHTO T 104, "Soundness of Aggregate by Use of Sodium Sulfate or Magnesium Sulfate." This test estimates the resistance of aggregate to weathering while in-service. It can be performed on both coarse and fine aggregate. The test is performed by alternately exposing an aggregate sample to repeated immersions in saturated solutions of sodium or magnesium sulfate each followed by oven drying. One immersion and drying is considered one soundness cycle. During the drying phase, salts precipitate in the permeable void space of the aggregate. Upon re-immersion the salt re-hydrates and exerts internal expansive forces that simulate the expansive forces of freezing water. The test result is total percent loss over various sieve intervals for a required number of cycles. Maximum loss values range from approximately 10 to 20 percent for five cycles. Iowa does not use the sulfate soundness test, but uses an actual freeze-thaw test with limits of 10 to 45 percent and surrogate chemical tests.

Deleterious Materials

Deleterious materials are defined as the weight percentage of contaminants such as shale, wood, mica, and coal in the blended aggregate. This property is measured by AASHTO T 112, "Clay Lumps and Friable Particles in Aggregates." It can be performed on both coarse and fine aggregate. The test is performed by wet sieving aggregate size fractions over prescribed sieves. The weight percentage of material lost as a result of wet sieving is reported as the percent of clay lumps and friable particles. A wide range of maximum permissible percentage of clay lumps and friable particles is evident. Iowa has a 0.5% limit for Type A aggregate.

ıBC9-0015
ɜC

IOWA DEPARTMENT OF TRANSPORTATION
OFFICE OF MATERIALS
TEST REPORT - ASPHALT CONCRETE
LAB LOCATION - AMES

LAB NO....:ABC9-0015

ıATERIAL........:RAP
NTENDED USE....:3/4" TYPE A BINDER-SURFACE
'ROJECT NO......:IM-35-5(71)111--13-85 CONTRACT #:93511
OUNTY..........:STORY CONTRACTOR:MANATTS
AMPLED BY......:TRUEBLOOD SENDER NO.:1MT9-12
ATE SAMPLED: 04/19/99 DATE RECEIVED: 04/19/99 DATE REPORTED: 04/27/99

EC. AGGREGATE ANGULARITY: 41.8
SA: 2.714
ABS: 2.46
SB: 2.544

SIEVE ANALYSIS PERCENT PASSING

IEVE	GRAM RETAINED	PERCENT RETAINED	PERCENT PASSING	COLD-FEED GRADATION	TARGET GRADATION	SPEC LOW LIMIT	SPEC HIGH LIMIT
/4			100.00				
/2			99.00				
/8			94.00				
			76.00				
			55.00				
;			42.00				
)			33.00				
)			21.00				
)0			14.00				
)0			11.50				

;PHALT CONCRETE RESULTS

AGGREGATE BY EXTRACTION	94.170
BITUMEN BY EXTRACTION	5.830

PIES TO:
CENTRAL LAB P PAGE TRUEBLOOD
CITC AMES RES.

SPOSITION:

SIGNED: KEVIN B. JONES
TESTING ENGINEER

RAP

Recycled asphalt is an option on some projects.

The following factors must be evaluated:

1. Quality of the aggregates in the old pavement
2. Characteristics of the old asphalt binder
3. Gradation of the aggregate in the recycled material
4. New aggregates to go with the recycled product

All mix design criteria must meet the appropriate specification.

On projects requiring removal of the old hot mix asphalt pavement down to the underlying concrete, the contractor is allowed to select the method of removal.

If scarification with a motor patrol or ripper is selected as the removal method, additional processing is generally required. The scarified recycled asphalt is hauled to the plant where it is run through a crusher to breakdown the larger pieces of RAP. It is then stockpiled.

When cold milling is the method used, it is usually not necessary to recrush the RAP prior to its use.

Some advantages to this procedure are:

1. Improved cross slope and profile
2. Less material handling
3. You can control the removal depth more easily with this procedure.

Material that has been crushed or cold milled must be stockpiled to meet specifications. The plant inspector may be involved in this. The important specs are:

1. You may truck dump the first lift for the base.
2. The minimum stockpile height shall be 8 ft (2.5 m).
3. The remainder of the pile shall be constructed with a loader, stacker, or similar equipment
4. Stacker placement shall be in 4 ft (1.2 m) layers.
5. Track equipment may be allowed to operate on the stockpile during its construction.

It is easy to build segregation into a stockpile or RAP if the proper procedures are not followed. If the stockpile is segregated, the mix gradation control is very difficult to maintain.

RAP shall be from a source designated, a certified stockpile or unclassified RAP furnished by the contractor. There are several specs relating to recycled material. (Sec 2303.02 C) Please take time to read these specifications.

Remember all unclassified RAP piles need to be sampled and tested by the District Materials Office prior to use.

When the contractor is working the RAP stockpile, it may be necessary to use a dozer to work the face of the stockpile if the pile has hardened to a point where an endloader cannot break it open. In this case, the RAP pile is fresh, so no dozer is required. Remember dozers can only be used on the pile during the building of the pile.

Materials

We are going into a short section discussing materials in hot mix asphalt mixtures.

Most HMA mixes are basic. They include aggregates and asphalt binder. We also use RAP in many hot mix asphalt mixes. HMA mixes can vary in the amount of crushed stone, natural sand, manufactured sand, and binder that are required.

Binder is used as the cementing agent in the mixture. It is a material that changes from a semi-solid to a liquid when heated. This allows it to coat the aggregate particles while hot and act as a cementing agent when cooled in the pavement.

Virtually all binder used in the U.S. is produced from crude oil, which is recovered from the ground using oil wells.

The crude oil is refined using the distillation process. In this process, heat is applied to the crude. The lighter volatile, such as gasoline, is the first to vaporize. After this, the medium volatile, such as diesel fuel, next is your heavier volatile, such as asphalt.

Types of Asphalt

- Asphalt Binder
- Cut-Back Asphalt
- Emulsified Asphalt

There are three types of asphalt used in Iowa projects and the technician should be familiar with all of them. We will cover the basics of these in this class. If more information were needed, your AC Plant Manual in Volume II would be a good reference for you to look at.

As a technician, you should know the type and grade you are using; the proper storage requirements, how it will be proportioned, the correct temperature range for each material, what documentation is necessary, and you should be knowledgeable about any problems that could arise.

Know These!

- Type
- Grade
- Storage
- Proportioning
- Documentation
- Problems

The current way of grading asphalt binder is based on asphalt rheology. This is the relationship between temperature and visco-elastic behavior.

The binder grades commonly used in Iowa are PG 58-28 and PG 64-22. Counties usually use PG 58-28. State jobs require PG 58-28 or PG 64-22.

Another product you may deal with is cutback asphalt. It is made from asphalt binder, which is diluted, with thinner. Cutbacks are primarily used for tack coat materials or as a seal coat binder-bitumen. They are classified as SC for slow cure, MC for medium cure, and RC for rapid cure.

Cut-Back Asphalt Grades

SS	MS	RS
Slow Set	Medium Set	Rapid Set

The third type of asphalt used is emulsion. It is the most common material used for tack application. It is made using asphalt binder, water, and an emulsifier that is similar to soap.

The grades of emulsion range from Rapid Set (RS) to Medium Set to Slow Set (SS).

Emulsion is a blend of asphalt binder and water. The emulsion must contain a certain percentage of binder. The lab runs a test to determine the percent of residue for emulsions. It is necessary to know whether the emulsion has been diluted at the project site for proper test results.

In closing, the materials are the basic items in an asphalt mix design. If you start with good materials and have a design that uses the correct aggregates and asphalt binder, you have taken a large step to a successful job.

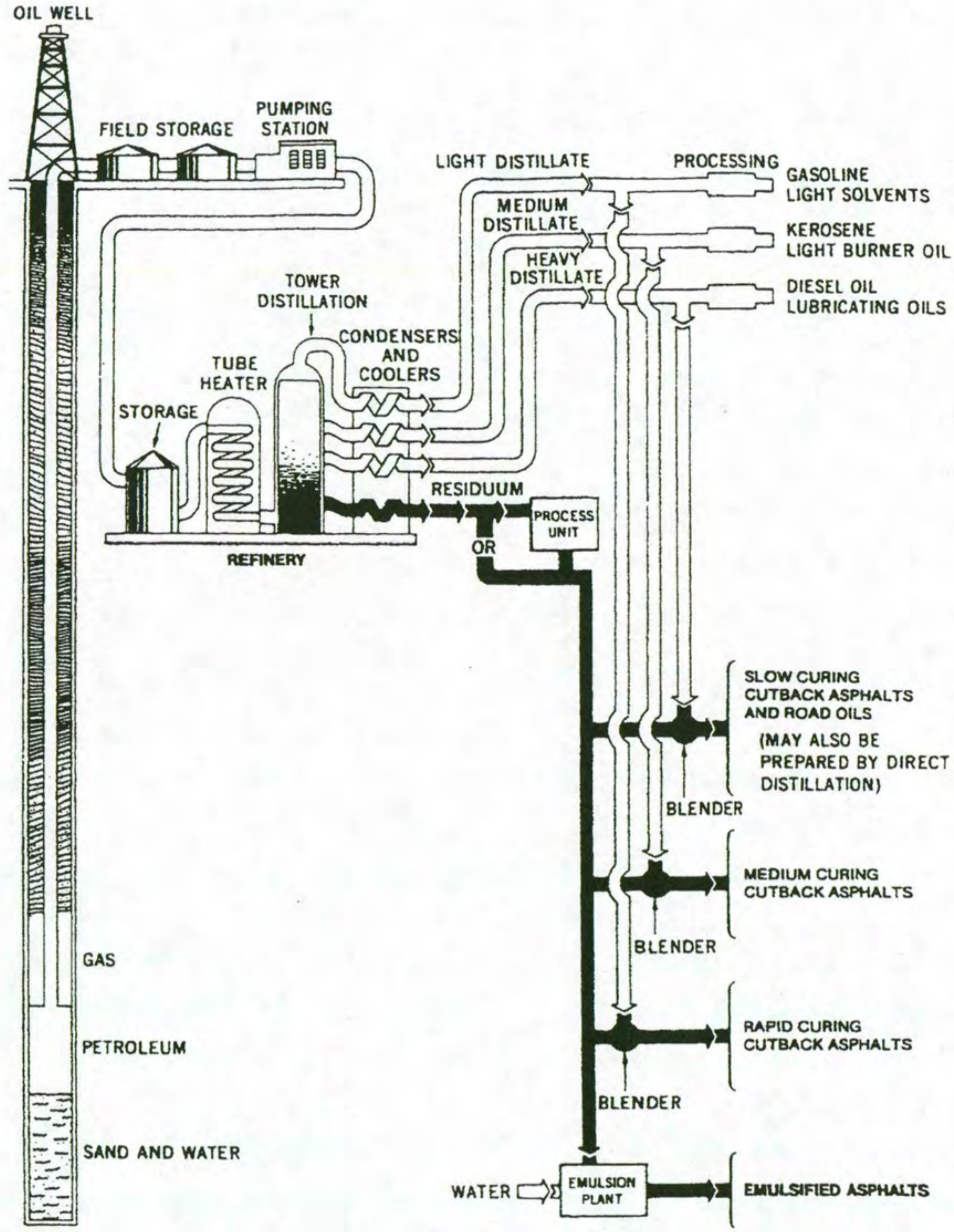
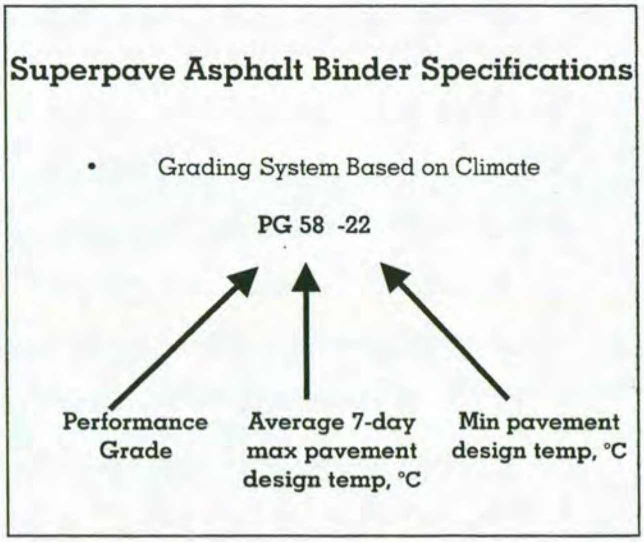


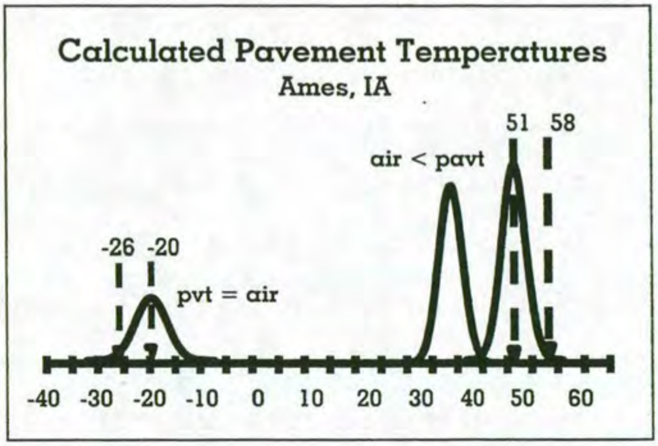
Figure 2-1. *Petroleum Asphalt Flow Chart for Emulsified and Cutback Asphalts.*

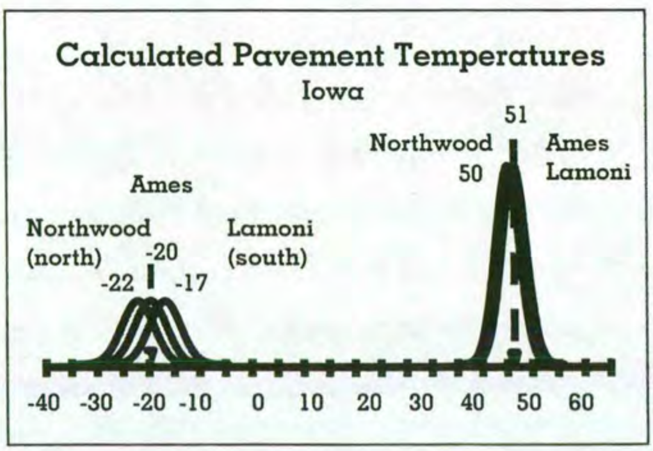
BINDER SELECTION

The determination of the Performance Grade, PG, binder to be used on a project is based primarily on the temperatures of the region. It is also based on the type of traffic on the roadway. Temperatures are used to deal with both hot and cold temperature problems. The pavement must be designed to appropriately deal with high temperature problems like rutting and cold temperature problems like cracking. There must be sufficient stiffness in the pavement to avoid rutting and yet enough flexibility to prevent cracking.



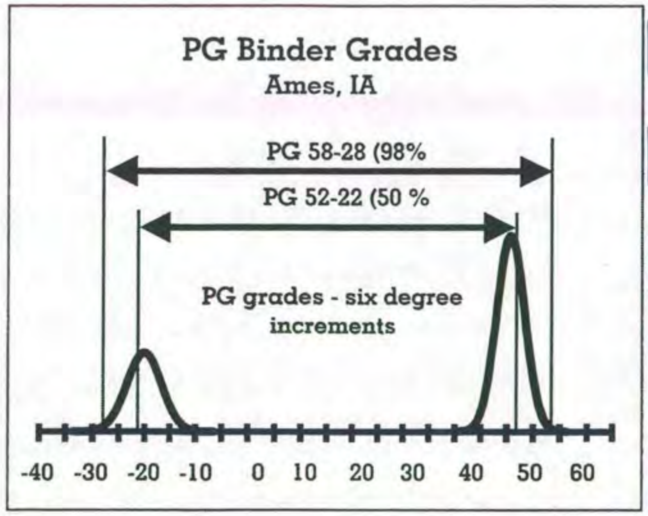
To determine the PG binder grade to be used, air temperatures are converted to pavement temperatures. For high temperature control the seven-day high average pavement temperature over a twenty-year time span is used. For low temperature control the individual low pavement temperature over a twenty-year time span is used. This will provide the basis for selecting the initial PG binder grade. In Iowa, the typical PG binder grades used are PG 58-28 and PG 64-22. The graphic below provides a means to interpret the binder grade designation.

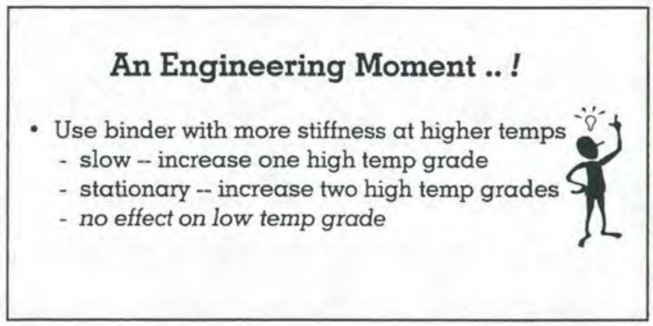


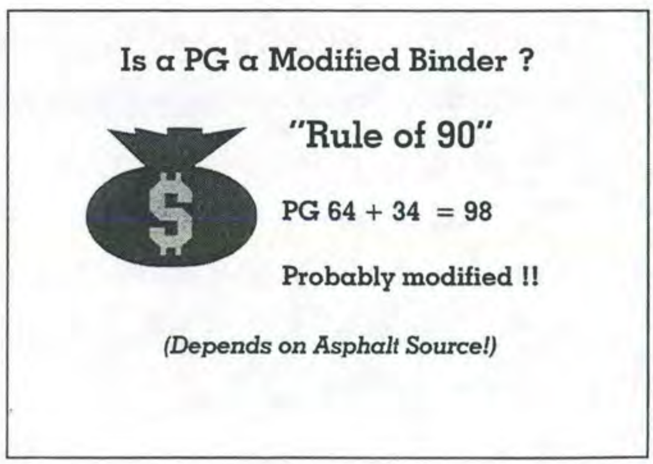


The PG binders are graded in increments of 6°C. Assume for instance that the average 7-day high pavement temperature is 51°C and the low pavement temperature is -20°C. For this instance the initial choice of binder grade would be

PG 52-22. This is the first binder grade, which will satisfy both pavement temperature needs. However, these are average pavement temperatures. There will be higher and lower temperatures occurring. A decision must be made as to how much reliability is desired for the binder. The example just described using a PG 52-22 would provide nominal 50 percent reliability. In many cases, there is a desire to provide greater reliability. The suggestion is that for interstates, federal and state primary roads and major roads the desired reliability is 98 percent. To achieve this, the binder grade must be adjusted in both the high and low temperature directions. This would mean moving the high temperature grade up one increment to 58 and the low temperature grade down one increment to –28. This would result in a PG 58-28 binder being used. This basically means that there would only be two years out of the hundred or about one year out of twenty that the environmental conditions would exceed the performance expectations.







The statement was also made that the binder grade determination was also based on the type of traffic. In instances where there is a great deal of slow moving traffic, the recommendation is to adjust the high temperature up one increment. For cases where there is a high likelihood of stationary traffic, the recommendation is to adjust the high temperature up two increments. For the previous example this would have meant going from a 58 to a 64 for slow traffic and a 70 for stationary traffic. This will **NOT** effect the low temperature grade.

The decision to use one grade of binder over another is sometimes based on cost. In some cases a PG binder must be modified to achieve the desired characteristics. The general rule is "Rule of 90". If the sum of the PG designated numbers is greater than 90 there is a good chance that the binder will have to be modified. For example, if a PG 64-34 is the desired binder grade, 64 + 34 = 98. This is probably a modified binder. It will depend on the source of the binder. In using this rule, the negative sign must be ignored.

Table 1. Superpave Binder Grades

High Temperature Grade	Low Temperature Grade
PG 46-	34, 40, 46
PG 52-	10, 16, 22, 28, 34, 40, 46
PG 58-	16, 22, 28, 34, 40
PG 64-	10, 16, 22, 28, 34, 40
PG 70-	10, 16, 22, 28, 34, 40
PG 76-	10, 16, 22, 28, 34
PG 82-	10, 16, 22, 28, 34

ESTIMATED PROJECT QUANTITIES

Division 1= 100% State of Iowa
Division 2= 100% City of Des Moines

100
07-

ITEM NO.	ITEM CODE	ITEM	UNIT	QUANTITIES ESTIMATED DIVISION 1	QUANTITIES ESTIMATED DIVISION 2	QUANTITIES ESTIMATED TOTAL	AS BUILT DIVISION 1	AS BUILT DIVISI
1	2102-2710070	EXCAVATION, CL 10, RDWY+BORROW	CY	460		460		
2	2123-7450020	SHLD FINISH, EARTH	STA	27		27		
3	2212-5070310	PATCH, FULL-DEPTH REPAIR	SY	560		560		
4	2212-5070320	PATCH, PARTIAL-DEPTH REPAIR	SY	94		94		
5	2212-5070330	PATCH BY COUNT (REPAIR)	EACH	136		136		
6	2212-5075000	SURF PATCH	TON	4		4		
7	2213-6745500	RMVL OF CURB	STA		33	33		
8	2214-5145150	PAV'T, SCARIFICATION	SY	33324		33324		
9	2301-4874500	MEDIAN, PCC	SY	2049		2049		
10	2303-0042500	HMA (3M ESAL) INTERMEDIATE, 1/2"	TON	4090		4090		
11	2303-0043500	HMA (3M ESAL) SURF, 1/2", NO FRIC	TON	4298		4298		
12	2303-0246422	ASPH BINDER, PG 64-22	TON	503		503		
13	2303-3400000	ADJUSTMENT OF FIXTURE	EACH	18		18		
14	2303-6911000	HMA PAV'T SAMPLE	LS	1		1		
15	2315-8275025	SURF, DRIVEWAY, CL A CR STONE	TON		34	34		
16	2510-6745850	RMVL OF PAV'T	SY	2050		2050		
17	2512-1725156	CURB+GUTTER, PCC, 1.5'	LF		3207	3207		
18	2512-1950000	CURB, DOWELLED PCC	LF	107		107		
19	2515-2475006	DRIVEWAY, PCC, 6"	SY		64	64		
20	2515-6745600	RMVL OF PAVED DRIVEWAY	SY		188	188		
21	2525-0000200	LOOP DETECTOR (ADD/RPLCMNT TO EXIST SYS)	EACH	26		26		
22	2527-9263111	PAINTED PAV'T MARK, WATERBORNE	STA	576		576		
23	2528-8445110	TRAFFIC CONTROL	LS	1		1		
24	2528-8445112	FLAGGER	DAY					
25	2529-5070110	PATCH, FULL-DEPTH FINISH, BY AREA	SY	136		136		
26	2529-5070120	PATCH, FULL-DEPTH FINISH, BY COUNT	EACH	17		17		
27	2530-0400061	HMA (PARTIAL DEPTH PATCH MAT'L)	TON	3		3		
28	2530-5070221	REGULAR PART DEPTH HMA FINISH PATCH AREA	SY	17		17		
29	2533-4980005	MOBILIZATION	LS	1		1		

2-31

Asphalt Binder at the Plant

Asphalt binder storage tanks are a variety of sizes and shapes, and they provide for storage, heating, and circulation of the binder. The inspectors have several concerns relating to binder storage.

There are some specifications and guidelines you must be familiar with as well as knowing the proper material to use and temperature at which to supply it to the mix. (Ref. 2303.02A, 2303.03B). These are beginning-of-the-job items that also require monitoring periodically. The last item, binder quantity, is a major responsibility of the plant inspector, and will be discussed in detail.

The storage facility includes the tank, an access port so that measurements can be taken, a safe and convenient way to get the access port, and a measuring stick to determine the quantity of binder in the tank.

The access ports are located on top of the tank. (You will be working with a contractor's representative when doing this work so let them open the port. If there is more than one port on the tank, be sure you check which one is to be used for measurements).

Safety First!

Do NOT begin operations until the access port area is safe!

We again emphasize your SAFETY. The top of tanks, especially round ones, is not the safest place to be. It can be windy, wet , and dirty. You must have a safe way to get to the port and a safe place to work when making the measurements. The contractor should not begin operations until this is provided.

Measurements of the level of binder are made by using a measuring "stick" which has been calibrated for use with a particular tank. The stick will be marked with the gallons (liters) in the tank, the gallons (liters) used from the tank, the diameter of the tank measured in inches (millimeters) or the percent of the tank that is filled.

The direct reading stick has irregular spacings if the tank is round. The percentage reading stick will have uniform gradations.

Each measuring stick should have the tank number on it. Some may have the tank capacity also. You must know the proper stick is being used to measure the binder quantity. The stick should have the tank number, the tank capacity, and the percent of capacity not filled with binder.

Stick should be labeled with:

- Tank Number
- Tank Capacity
- Percent of Capacity not filled with binder

The measurement is taken from the top of the tank to the level of the binder. The measurement should be recorded immediately after being read, and should be observed by and agreed to by both the contractor and the plant (or project) inspector.

Most tank sticks will need to be converted into a quantity. From a stick that shows inches (millimeters) of asphalt remaining, you can establish a chart that converts the measurements to gallons (liters). It may be necessary for the inspector to use the tables in I.M. T-104 to obtain the quantity of asphalt binder in the tank.

The tankstick measurement is used to determine how much asphalt binder was used during the time period checked. There are two other methods that may be used to determine binder quantities: by a totalizer attached to a properly calibrated flow meter, or by totalizing the batch weights in a batch plant. The information gathered must be entered in the appropriate field book.

Asphalt Binder Quantity

- Percent in the mix
- Target and Tolerance
- Pay Quantity

There are three reasons to determine the binder quantity. First, to determine the percentage of binder in the mix. Second, to see that the percent is on target and within the tolerance. Third, is to determine the quantity that will be paid for as part of the contract.

The percent of asphalt binder we want the contractor to put into the mix is determined by the mix design (already discussed). The tolerance for percentage of binder is found in Article 2303.04B. The quantities for pay are described in Article 2303.05B.

The asphalt binder determination worksheet is a basic tool for the plant inspector. The complete instructions on how to fill out the form are in I.M. 509, found in your AC Plant Manual.

Form 956 ver.3.0

Iowa Department of Transportation

Highway Division - Office of Materials

HMA Gyratory Mix Design

County : POLK	Project : NHS-6-3(41)--12-77	Mix No. :	ABD8-1007
Size : 3/4"	Contractor : Quality Asphalt Inc.	Contract No. :	77-0006-41
Mix Type: 30M ESAL	Design Life ESAL's : 14,858,310	Date Reported :	06/01/98
Intended Use : Surface	Project Location : Hwy. 6 in Altoona		

Aggregate & Source:	3/4 Minus	A35002	DOWS, BEDS 9-12	@	40.0%
	Chip	A42002	ALDEN, BED 3	@	32.0%
	Man. Sand	A17008	PORTLAND, BEDS 1-7	@	23.0%
	Nat. Sand	A35512	ANDERSON PIT	@	5.0%

Job Mix Formula - Combined Gradation (Sieve Size in.)

	1"	3/4"	1/2"	3/8"	#4	#8	#16	#30	#50	#100	#200
Upper Tolerance	100	100	97	90	57	33		15			5.3
	100	100	90	83	50	28	17	11	6.7	4.1	3.3
Lower Tolerance	100	93	83	76	43	23		7			1.3

Asphalt Binder Source and Grade: Bituminous Materials, Tama PG 58-28

	Gyratory Data				Interpolated
% Asphalt Binder	4.79	5.29	5.79	6.29	5.40
Corrected Gmb @ N-Des.	2.340	2.364	2.387	2.389	2.369
Max. Sp.Gr. (Gmm)	2.486	2.473	2.450	2.439	2.468
% Gmm @ N- Initial	82.3	83.8	87.8	88.4	84.7
%Gmm @ N-Max	96.6	97.6	99.2	100.0	98.0
% Air Voids	5.9	4.4	2.6	2.1	4.0
% VMA	13.6	13.1	12.7	13.1	13.0
% VFA	56.7	66.4	79.8	84.4	69.4
Film Thickness	9.8	11.0	12.7	13.8	11.4
Filler Bit. Ratio	0.98	0.88	0.76	0.70	0.85
Gsb	2.577	2.577	2.577	2.577	2.577
Gse	2.678	2.685	2.679	2.688	2.683
Pbe	3.36	3.78	4.36	4.75	3.91
Pba	1.50	1.60	1.51	1.64	1.56
% New Asphalt Binder	100.0	100.0	100.0	100.0	100.0
Asphalt Binder Sp.Gr. @ 25c	1.024	1.024	1.024	1.024	1.024
% Water Abs	2.46	2.46	2.46	2.46	2.46
S.A. m^2 / Kg.	3.44	3.44	3.44	3.44	3.44
% + 4 Friction Agg.	53.8	53.8	53.8	53.8	53.8
Angularity-method A	46	46	46	46	46
% Flat & Elongated	3.4	3.4	3.4	3.4	3.4
Coarse Agg. Angularity	100/100	100/100	100/100	100/100	100/100
Sand Equivalent	50	50	50	50	50

Number of Gyrations

N-Initial: 8

N-Design: 109

N-Max: 174

Gsb for Angularity Method A: 2.666

Pba / %Abs Ratio: 0.64

Slope of Compaction Curve: 10.1

Disposition : An asphalt binder content of 5.4% is recommended to start this project.

Data shown in 5.40% column is interpolated from test data.

Comments :

Copies to : Quality Asphalt Inc. Dist 1 Matls. Des Moines RCE Cent. Materials

Signed : John Rasjson

Form 955 ver.3.0

Iowa Department of Transportation

Highway Division-Office of Materials

Proportion & Production Limits For Aggregates

County : POLK   Project No.: NHS-6-3(41)--12-77   Date: 06/01/98

Project Location: Hwy. 6 in Altoona   Mix Design No.: ABD8-1007

Contract Mix Tonnage: 10,000   Course: Surface   Mix Size: 3/4"

Contractor: Quality Asphalt Inc.   Mix Type: 30M ESAL   Design Life ESAL's:14,858,310

Material	Ident #	% in Mix	Producer & Location	Gsb	%Abs
3/4 Minus	A35002	40.0%	DOWS, BEDS 9-12	2.555	2.65
Chip	A42002	32.0%	ALDEN, BED 3	2.575	2.13
Man. Sand	A17008	23.0%	PORTLAND, BEDS 1-7	2.712	1.85
Nat. Sand	A35512	5.0%	ANDERSON PIT	2.603	0.69

Type and Source of Asphalt Binder: PG 58-28   Bituminous Materials, Tama

Individual Aggregates Sieve Analysis - % Passing (Target)

Material	1"	3/4"	1/2"	3/8"	#4	#8	#16	#30	#50	#100	#200
3/4 Minus	100	100	75	60	33	20	14	11	9.7	7.9	6.8
Chip	100	100	100	97	29	1.3	0.6	0.4	0.4	0.3	0.3
Man. Sand	100	100	100	100	99	68	35	19	9.0	3.5	2.0
Nat. Sand	100	100	100	100	98	84	66	40	12	1.4	0.6

Preliminary Job Mix Formula Target Gradation

Upper Tolerance	100	100	97	90	57	33		15			5.3
Comb Grading	100	100	90	83	50	28	17	11	6.7	4.1	3.3
Lower Tolerance	100	93	83	76	43	23		7			1.3
S.A.sq. m/kg	Total	3.44		+0.41	0.27	0.39	0.62	0.77	0.80	1.00	2.23

Production Limits for Aggregates Approved by the Contractor & Producer.

Sieve Size in.	40.0% of mix 3/4 Minus		32.0% of mix Chip		23.0% of mix Man. Sand		5.0% of mix Nat. Sand			
	Min	Max	Min	Max	Min	Max	Min	Max		
1"	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0		
3/4"	98.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0		
1/2"	68.0	82.0	98.0	100.0	100.0	100.0	100.0	100.0		
3/8"	53.0	67.0	90.0	100.0	98.0	100.0	98.0	100.0		
#4	26.0	40.0	22.0	36.0	92.0	100.0	91.0	100.0		
#8	15.0	25.0	0.0	6.3	63.0	73.0	79.0	89.0		
#30	7.0	15.0	0.0	4.4	15.0	23.0	36.0	44.0		
#200	4.8	8.8	0.0	2.3	0.0	4.0	0.0	2.6		

Comments:

The above target gradations and production limits have been discussed with and agreed to by an authorized representative of the aggregate producer.

Signed: Joe Smith   Signed: John Rayson

Producer   Contractor

Form 956 ver.3.0

Iowa Department of Transportation

Highway Division - Office of Materials

HMA Gyratory Mix Design

County : Story	Project : IM-35-5(71)111--13-85	Mix No. :	1BD9-016
Size : 3/4"	Contractor : Manatts Inc.	Contract No. :	85-0355-071
Mix Type: HMA1M ESAL	Design Life ESAL's : 200,000	Date Reported :	06/04/99
Intended Use : Shoulder	Project Location : I-35 Story County		

Aggregate & Source:	Man. Sand	A85006	Martin Marietta, Ames Mine, Beds 19-26	@	9.0%
	Sand	A85510	Hallett Materials, Ames Pit	@	28.0%
	3/4 Chip	A85006	Martin Marietta, Ames Mine, Beds 19-26	@	27.0%
	RAP		AC Millings from Project I-35	@	36.0%

Job Mix Formula - Combined Gradation (Sieve Size in.)

	1"	3/4"	1/2"	3/8"	#4	#8	#16	#30	#50	#100	#200
Upper Tolerance	100	100	94	81	62	49		23			5.1
	100	99.7	87	74	55	44	33	19	8.5	4.1	3.1
Lower Tolerance	100	93	80	67	48	39		15			1.1

Asphalt Binder Source and Grade: Bituminous Materials, Tama PG58-28

	Gyratory Data				Interpolated	
% Asphalt Binder	5.18	5.68	6.18	6.68	5.52	
Corrected Gmb @ N-Des.	2.350	2.374	2.370	2.377	2.366	
Max. Sp.Gr. (Gmm)	2.461	2.429	2.421	2.413	2.440	Number of Gyrations
% Gmm @ N- Initial	89.9	92.0	92.2	92.7	91.3	N-Initial
%Gmm @ N-Max	96.3	98.5	98.8	99.2	97.8	7
% Air Voids	4.5	2.3	2.1	1.5	3.0	N-Design
% VMA	14.1	13.7	14.3	14.5	13.8	68
% VFA	68.1	83.5	85.3	89.7	78.4	N-Max
Film Thickness	10.1	12.0	12.8	13.6	11.4	104
Filler Bit. Ratio	0.75	0.63	0.59	0.56	0.67	
Gsb	2.595	2.595	2.595	2.595	2.595	
Gse	2.665	2.647	2.659	2.672	2.661	Gsb for Angularity
Pbe	4.20	4.95	5.29	5.62	4.70	Method A
Pba	1.04	0.78	0.95	1.14	0.98	2.618
% New Asphalt Binder	68.0	71.0	73.5	75.6	70.1	
Asphalt Binder Sp.Gr. @ 25c	1.026	1.026	1.026	1.026	1.026	Pba / %Abs Ratio
% Water Abs	1.96	1.96	1.96	1.96	1.96	0.50
S.A. m^2 / Kg.	4.14	4.14	4.14	4.14	4.14	
% + 4 Friction Agg.						
Angularity-method A	41	41	41	41	41	Slope of Compaction
% Flat & Elongated	0.0	0.0	0.0	0.0	0.0	Curve
Coarse Agg. Angularity	100/100	100/100	100/100	100/100	100/100	18.0
Sand Equivalent	55	55	55	55	55	

Disposition : An asphalt binder content of 5.5% is recommended to start this project.

Data shown in 5.52% column is interpolated from test data.

The % ADD asphalt binder to start project is 3.9% RAP Contains 4.77% Asphalt Binder

Comments : RAP contains 80% crushed particles.

Copies to : Manatts Inc. Dist 1 Matls. Hallett Materials Cent. Materials Martin Marietta Ames RCE

Signed : Cindy Delarosa

Form 955 ver.3.0

Iowa Department of Transportation

Highway Division-Office of Materials

Proportion & Production Limits For Aggregates

County : Story | Project No.: IM-35-5(71)111--13-85 | Date: 06/04/99

Project Location: I-35 Story County | Mix Design No.: 1BD9-016

Contract Mix Tonnage: 11,000 | Course: Shoulder | Mix Size: 3/4"

Contractor: Manatts Inc. | Mix Type: HMA1M ESAL | Design Life ESAL's:200,000

Material	Ident #	% in Mix	Producer & Location	Gsb	%Abs
Man. Sand	A85006	9.0%	Martin Marietta, Ames Mine, Beds 19-26	2.632	1.96
Sand	A85510	28.0%	Hallett Materials, Ames Pit	2.615	0.77
3/4 Chip	A85006	27.0%	Martin Marietta, Ames Mine, Beds 19-26	2.652	1.54
RAP		36.0%	AC Millings from Project I-35	2.633	1.11

Type and Source of Asphalt Binder: PG58-28 Bituminous Materials, Tama

Individual Aggregates Sieve Analysis - % Passing (Target)

Material	1"	3/4"	1/2"	3/8"	#4	#8	#16	#30	#50	#100	#200
Man. Sand	100	100	100	100	99	71	44	23	10	3.8	2.1
Sand	100	100	100	100	97	85	64	32	7.7	0.6	0.2
3/4 Chip	100	100	60	27	2.4	0.8	0.7	0.7	0.7	0.6	0.6
RAP	100	99	93	84	51	36	29	23	15	9.8	7.8

Preliminary Job Mix Formula Target Gradation

Upper Tolerance	100	100	94	81	62	49		23			5.1
Comb Grading	100	100	87	74	55	44	33	19	8.5	4.1	3.1
Lower Tolerance	100	93	80	67	48	39		15			1.1
S.A.sq. m/kg	Total	4.14		+0.41	0.27	0.39	0.62	0.77	0.80	1.00	2.23

Production Limits for Aggregates Approved by the Contractor & Producer.

Sieve Size in.	9.0% of mix Man. Sand		28.0% of mix Sand		27.0% of mix 3/4 Chip		36.0% of mix RAP			
	Min	Max	Min	Max	Min	Max	Min	Max		
1"	100.0	100.0	100.0	100.0	100.0	100.0				
3/4"	100.0	100.0	100.0	100.0	98.0	100.0				
1/2"	100.0	100.0	100.0	100.0	53.0	67.0				
3/8"	98.0	100.0	98.0	100.0	20.0	34.0				
#4	92.0	100.0	90.0	100.0	-4.6	9.4				
#8	66.0	76.0	80.0	90.0	0.0	5.8				
#30	19.0	27.0	28.0	36.0	0.0	4.7				
#200	0.1	4.1	0.0	2.2	0.0	2.6				

Comments:

The above target gradations and production limits have been discussed with and agreed to by an authorized representative of the aggregate producer.

Signed: Joe Smith
Producer

Signed: Cindy Delarosa
Contractor

IOWA DEPARTMENT OF TRANSPORTATION
OFFICE OF MATERIALS
ASPHALT CONCRETE MIX DESIGN
LAB LOCATION AMES

MATERIAL: TYPE A — LAB NO.: ABD8-1007
INTENDED USE: SURFACE — CONTRACT NUMBER:
SIZE: 3/4 in. SPEC. NO.: GS-97003 — DATE REPORTED: 10-20-1999
COUNTY: POLK — PROJECT: NHS-6-3(41)--12-77
CONTRACTOR: QUALITY ASPHALT INC. — ADT: 9900
PROJ. LOCATION: US HWY 6 IN ALTOONA

AG. SOURCES: 3/4" CR. LMST.-SMILING JOES AGGREGATES, BEDS 1-3 A77009 @ 30%
3/4" CLEAN-SMILING JOES AGGREGATES, BEDS 4-7 A77009 @ 15%
1/2" CHIPS-SMILING JOES AGGREGATES, BEDS 4-7 A77009 @ 35%
SAND-BEST SAND AND GRAVEL @ ALTOONA @ 20%

JOB MIX FORMULA-COMBINED GRADATION

	1-1/2	1	3/4	1/2	3/8	#4	#8	#16	#30	#50	#100	#200
	100	100	100	89	75	41	27	20	12	6.2	3.8	2.6
TOLERANCE			98/100	7	7	7	5		4			2

ASPHALT SOURCE AND GRADE: PG 58-28 BITUMINOUS MATERIALS, TAMA

% ASPHALT IN MIX	4.00	5.00	5.21	6.00
NUMBER OF MARSHALL BLOWS	50	50	50	50
MARSHALL STABILITY LBS.	3300	3150	3123	3020
FLOW - 0.01 IN.	8	9	9	10
MARSHALL SP GR-LAB DENS.	2.318	2.331	2.335	2.352
BULK SP GR COMBINED AGGR	2.601	2.601	2.601	2.601
SP. GR. ASPHALT @ 77 F	1.024	1.024	1.024	1.024
CALC. MAX. SP. GR.	2.477	2.440	2.433	2.405
CALCULATED % VOIDS	6.42	4.47	4.00	2.20
MAX. SP. GR. - RICE	2.477	2.440	2.433	2.405
% VOIDS - RICE	6.42	4.47	4.00	2.20
% WATER ABSORPTION AGGR	1.50	1.50	1.50	1.50
% VOIDS IN MINERAL AGGR	14.45	14.86	14.89	15.00
% V.M.A. FILLED WITH AC	55.56	69.94	73.11	85.31
FILM THICKNESS-MICRONS	11.15	14.37	15.02	17.53
FILLER/BITUMEN RATIO	0.65	0.52	0.50	0.43
EFFECTIVE SP GR - AGGR	2.633	2.632	2.632	2.632
CALC. % AC ABSORPTION	0.47	0.46	0.46	0.46
CALC. BULK SP. GR.-AGGR.	2.583	2.582	2.582	2.582

MINIMUM %AC FOR THIS AGGREGATE COMBINATION IS 5.03%

DISPOSITION: AN ASPHALT CONTENT OF 5.2% IS RECOMMENDED TO START THE JOB

COMMENTS:

RESULTS SHOWN IN 5.21 COLUMN ARE INTERPOLATED FROM TEST DATA.

COPIES TO: CENTRAL LAB QUALITY ASPHALT INC. TCME
AC TECH RCE

NOTE--STANDARD SPECIFICATIONS CHANGED! — SIGNED: KEVIN JONES
ENGINEER

ORM 955QMA

IOWA DEPARTMENT OF TRANSPORTATION
PROJECT DEVELOPMENT DIVISION-OFFICE OF MATERIALS
PROPORTIONS & PRODUCTION LIMITS FOR AGGREGATES

OUNTY: POLK   PROJECT NO.: NHS-6-3(41)--12-77   DATE: 05/20/99
ROJECT LOCATION: US HWY 6 IN ALTOONA
YPE OF MIX: A   CLASS OF MIX: COURSE: SURFACE   MIX SIZE: 3/4"
ONTRACTOR: QUALITY ASPHALT INC.   TRAFFIC: 9900 A.D.T.

MATERIAL	IDENT #	% IN MIX	PRODUCER & LOCATION
3/4" CR. LMST.	A77009	30	SMILING JOES AGGREGATES, BEDS 1-3 A77009
3/4" CLEAN	A77009	15	SMILING JOES AGGREGATES, BEDS 4-7 A77009
1/2" CHIPS	A77009	35	SMILING JOES AGGREGATES, BEDS 4-7 A77009
SAND	A77555	20	BEST SAND AND GRAVEL @ ALTOONA

TYPE AND SOURCE OF ASPHALT CEMENT: PG 58-28 BITUMINOUS MATERIALS, TAMA

MATERIAL	INDIVIDUAL AGGREGATES SIEVE ANALYSIS -% PASSING (Target)											
	1-1/2	1	3/4	1/2	3/8	4	8	16	30	50	100	200
3/4" CR. LMST.	100	100	100	77	64	42	27	20	15	12	10	7.1
3/4" CLEAN	100	100	100	75	47	7.5	1.4	1.3	1.2	1.1	1.0	0.9
1/2" CHIPS	100	100	100	100	83	24	4.8	2.9	2.0	1.7	1.2	0.7
SAND	100	100	100	100	100	95	83	63	33	9.2	1.3	0.4

PRELIMINARY JOB MIX FORMULA TARGET GRADATION

	1-1/2	1	3/4	1/2	3/8	4	8	16	30	50	100	200
TOLERANCE			98/100	7	7	7	5		4			2
COMB GRADING	100	100	100	89	75	41	27	20	12	6.2	3.8	2.6
SURFACE AREA C.	TOTAL					0.02	0.04	0.08	0.14	0.30	0.60	1.60
S.A. SQ. FT./LB.	15.45				+2.0	0.8	1.1	1.6	1.7	1.9	2.3	4.1

PRODUCTION LIMITS FOR AGGREGATES APPROVED BY THE CONTRACTOR & PRODUCER

SIEVE SIZE	30.00% 3/4" CR. LMST.		15.00% 3/4" CLEAN		35.00% 1/2" CHIPS		20.00% SAND			
	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX
1	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0		
3/4	98.0	100.0	98.0	100.0	100.0	100.0	100.0	100.0		
1/2	70.0	84.0	68.0	82.0	98.0	100.0	100.0	100.0		
3/8	57.0	71.0	40.0	54.0	76.0	90.0	98.0	100.0		
#4	35.0	49.0	0.5	14.5	17.0	31.0	88.0	100.0		
#8	22.0	32.0	0.0	6.4	0.0	9.8	78.0	88.0		
#30	11.0	19.0	0.0	5.2	0.0	6.0	29.0	37.0		
#200	5.1	9.1	0.0	2.9	0.0	2.7	0.0	2.4		

OMMENTS:

he above target gradations and production limits have been discussed with and greed to by an authorized representative of the aggregate producer.

igned____________________ Signed____________________

Producer   Contractor

What is an ESAL?

As the paving industry continues it's move to Gyratory, many terms relating to design and pavement life are being thrown around. This article will explain one of these terms, as ESAL.

A number of the parameters set up for deciding which performance grade binder and Gyratory mix design are based on the "number of ESAL's expected on that roadway for 20 years".

ESAL stands for Equivalent Single Axle Road. The standard axle load is usually an 18,000 lb. single axle load with dual wheels. Other magnitudes and types of axles are then related to the 18,000 lb. single axle load by their damage effect on a pavement. An ESAL factor is developed for each vehicle class through truck weight studies on various routes throughout the state. Once these are known, the total ESAL's can be calculated by multiplying the number of vehicles in a class by the ESAL factor for that class.

The relative damage effect of different axles was initially determined from pavement performance studies at the AASHTO Road Test in the early 1960's. Most current design procedures still use the factors determined at the Road Test because this is the only comprehensive study where applications of the same axle loads only were run over given pavements to determine their performance.

What is the relative damage? The research has shown that the relative damage is about the fourth power of the ratio of the loads. Therefore, doubling the load would cause 16 times the damage. Also, increasing the load by only 10% increased the damage effect by 50%.

To calculate the accumulation of ESAL's for a given roadway, it is necessary to predict or determine the following:

1. The total traffic in the design lane; usually in ADT (Average Daily Traffic) in the design lane. Multiply the ADT by 365 to be given an annual value. To achieve the total number, the annual value is multiplied by the years being designed for.
2. The vehicle type distribution in the traffic mix. Trucks will cause the ESAL's to accumulate faster because of the higher axle loads. Iowa DOT uses 7 classes of trucks. Typical traffic mixes can vary from 2 – 3% up to over 30% on public roads.

The calculations of ESAL's determine the amount of gyrations necessary during the design phase. For more information on Gyratory design, please contact the APAI office.

10-27-98 101-4

DESIGN DATA RURAL

1998	AADT	9,500	V.P.D.
2018	AADT	12,300	V.P.D.
20	DHV		V.P.H.
TRUCKS		7	%
Total Design ESALs		2,848,950	

HOT MIX ASPHALT PLANTS

This section of the course deals with the types of asphalt plants and equipment used in processing materials to make mix. The three types of plants we will discuss are batch plants, drum mix plants, and continuous plants.

ASPHALT PLANT TYPES

- Batch Plants
- Drum Mix Plants
- Continuous Plants

The basic function of the hot mix asphalt (HMA) plant are common to all types of plants. The inspector has some jobs to perform for each of these functions. Your job may be as simple as occasionally observing the stockpiling of aggregate, or it may be as detailed as calculating the asphalt binder quantities from tankstick measurements.

GOOD INSPECTORS KNOW:

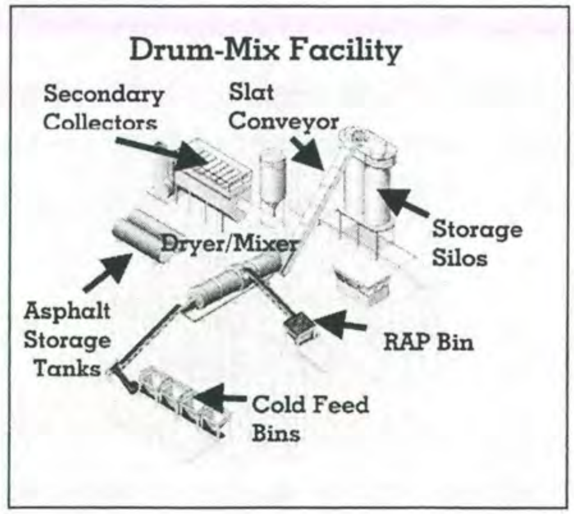
- Why things happen
- How they happen
- What can be done to correct the problem

run moistures twice a day

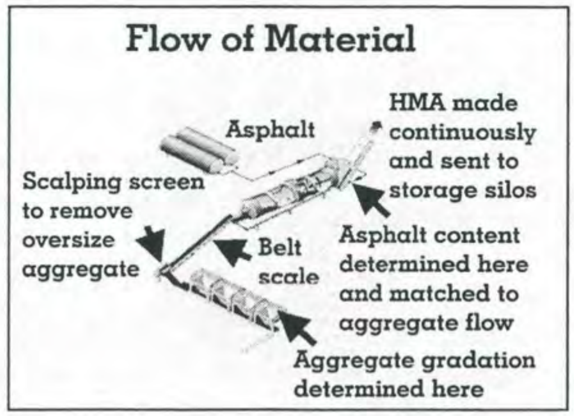
(once per 1/2 day)

DRUM MIX PLANTS

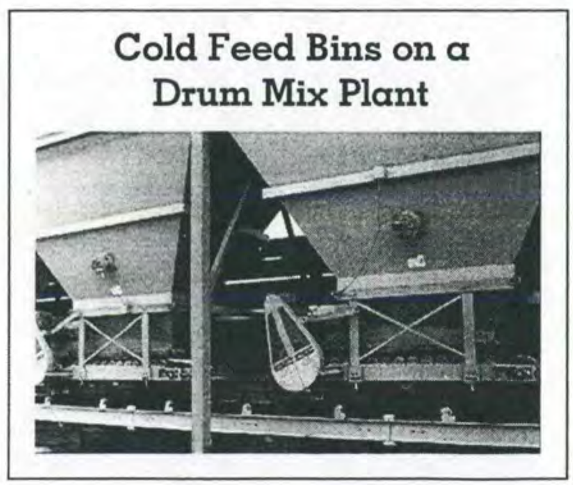
Like all other types of HMA plants, the drum plant's purpose is to combine aggregates and asphalt binder in such a way as to produce a mixture that meets job requirements.



The production process involves proportioning aggregates of various sizes into the proper mix gradation, drying and heating the aggregate particles, adding the right amount of heated binder, mixing these materials together, and storing the finished mix before depositing it into trucks for delivery to the job site.



Aggregates and binder are delivered to the plant before and during production. Aggregates are stockpiled in a way that avoids segregation and contamination; hot asphalt binder is kept heated in storage tanks.



Each aggregate stockpile contains particles of a specific size or range of sizes. Separation of stockpiles prevents the different sized aggregates from mingling.

From stockpiles, the aggregates are fed directly into underground conveyor tunnels or loaded into cold bins form which they are drawn as needed. During production, it's important that stockpiles and bins are well supplied. An aggregate shortage could cause an interruption of plant operations.

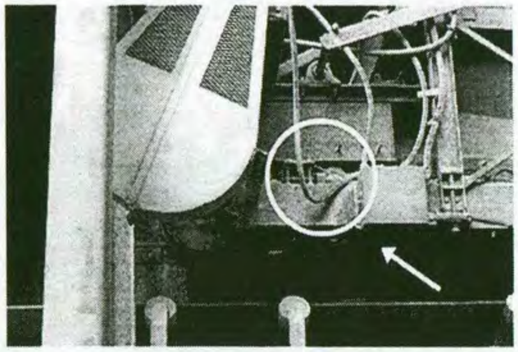
Cold aggregates are drawn from stockpiles and bins through cold feed gates. Each gate is calibrated and set to control the flow rate of a certain size of aggregate. If all gate openings are properly coordinated, the combined flow of materials form the different bins or stockpiles will contain the right amount of each size of aggregate required for the finished mix.

The accuracy of cold feed operation is especially important in drum mix plants because, unlike batch plants, they have no secondary proportioning system. The aggregate gradation leaving the cold feed system becomes the gradation of the mix. For this reason, the gradation of the aggregates, stockpiles, and the function of the cold feed system should be checked frequently during operation.

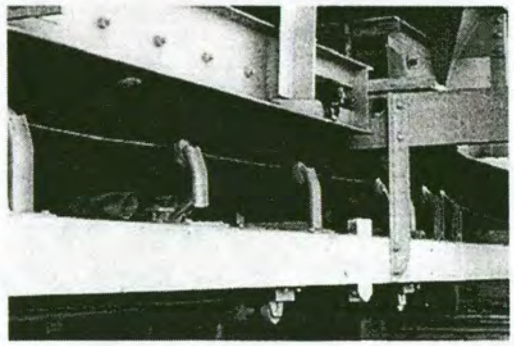
From the cold feed system, a conveyor belt carries the material to a second conveyor.

Two features of this conveyor system are particularly important to the inspector. The first is the aggregate weighing device called a weigh bridge; usually located midway along the length of the belt.

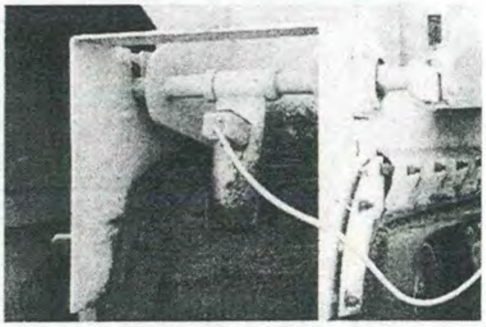
Belt Scale Located on Feeder



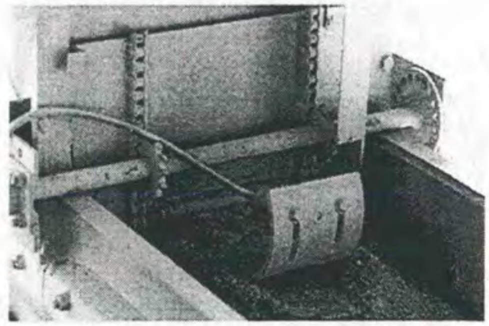
Belt Scale Located Below and Between Feeder Belts



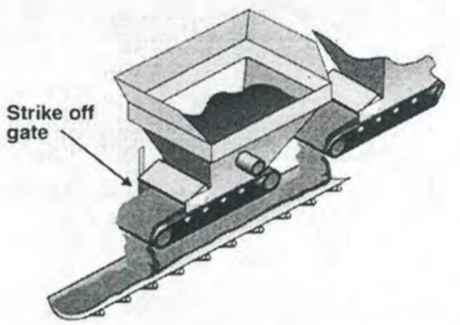
"No Flow" Paddle at Feeder Discharge



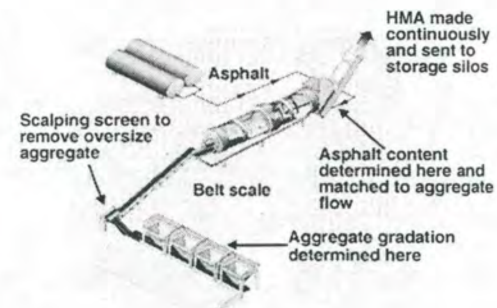
Partial Flow Ski at Feeder Discharge



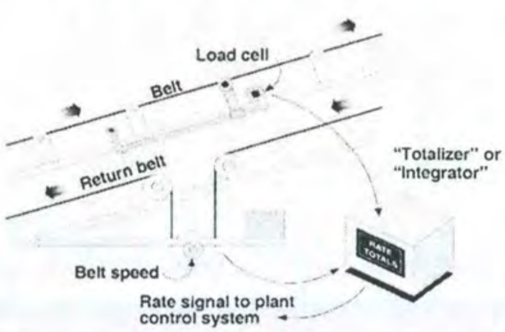
Cold Feed Bin Showing Strike-off Gate



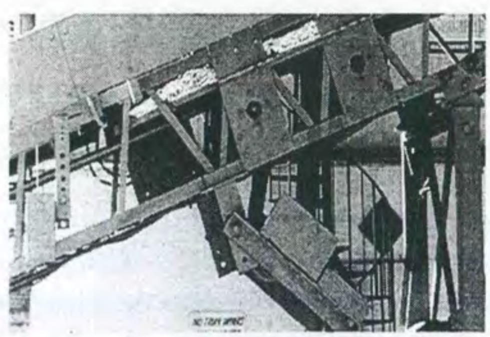
Belt Scale



How a Belt Scale Works



Weigh Bridge



A typical weigh bridge consists of a series of conveyor idlers. One of these, the weigh idler, is mounted on a scale allowing it to weigh the aggregate passing over it.

A visual display in the plant control room gives continuous weight readings in tons (Mg) per hour. As we'll see later, the weigh bridge is interlocked with the asphalt binder metering system so that the proportions of aggregates and binder used in the mixture remain constant.

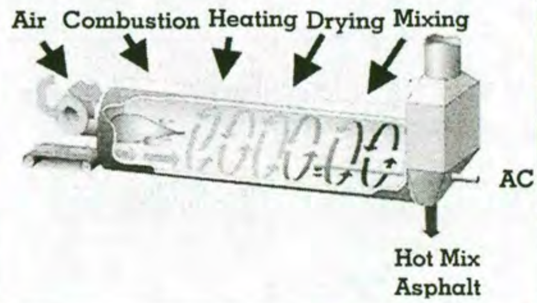
The second feature of the conveyor system is the aggregate sampling device, usually located at the top end of the conveyor, adjacent to the drum mixer entrance port. The device allows personnel to divert a time sample of cold aggregates into a container for testing. This gives the inspector and the laboratory a means of checking that aggregates entering the drum meet gradation requirements.

The drum mixer, also referred to as the drying drum mixer, is the central component of the plant. Within it, the aggregates are heated, dried, and combined with the proper proportion of asphalt binder.

The burner that produces the flame for heating and drying the aggregates is located at the same end of the drum as the aggregate feed port.

Parallel-Flow Drum Mix Plant

Parallel-Flow Drum-mixers Zones



Insufficient Veiling

Rotation too slow, material falls short

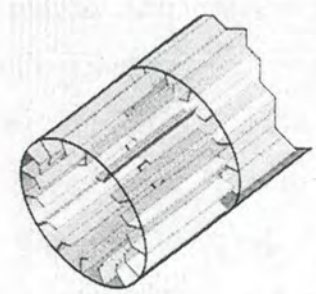
Overveiling

Rotation too fast, material pitches long

Proper Veiling of Aggregate

Proper rotation speed

Staggered Rows of Flights

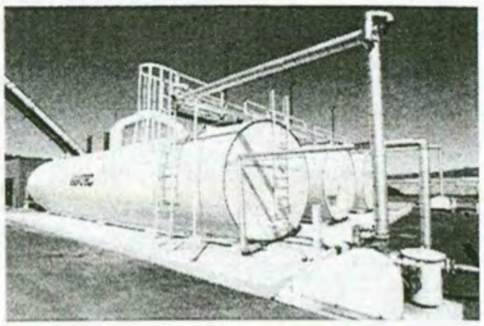


Functional Activities - Dryers

- Combustion
- Drying
- Heating

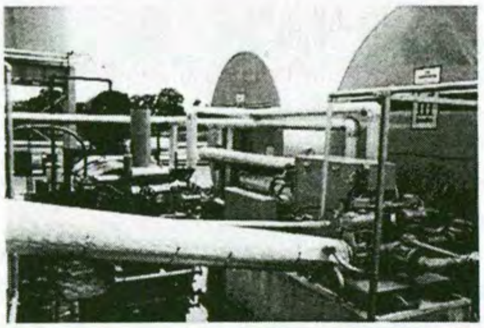
3 Types of Heat Transfer in Aggregate Dryer

Multiple Horizontal Tanks

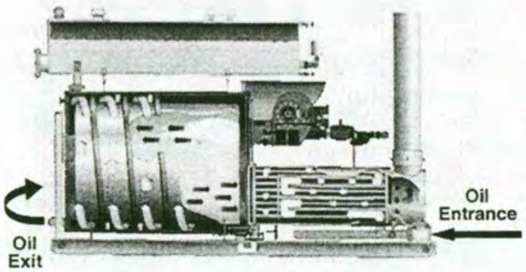


Portable Asphalt Tank

Hot Oil Pipes for Asphalt Tanks



Cutaway Illustration of CEI Hot Oil Heater



Hot Oil Heater to Heat Asphalt Tanks

Natural Convective Currents in Asphalt Storage Tanks

Binder is introduced away from the direct heat of the burner flame.

The inside wall of the drum mixer is lined with lifters called flights. Two or more flights are used in most drum mixers to lift and direct the aggregate in different ways as it moves through the drum.

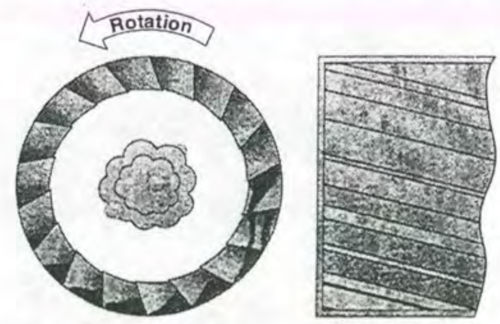
Within the drum mixer, operations occur in two phases. In the preliminary phase, aggregates enter and are dropped in a veil pattern through the burner flame. Aggregate temperature increases dramatically and most of the moisture is driven off.

The secondary phase occurs where binder is introduced. As asphalt binder sprays into the drum it meets the moisture that has been driven off the aggregates. The combination of binder and moisture causes the binder to foam.

The foamed binder literally engulfs the aggregate particles, rapidly coating them and providing uniform coverage.

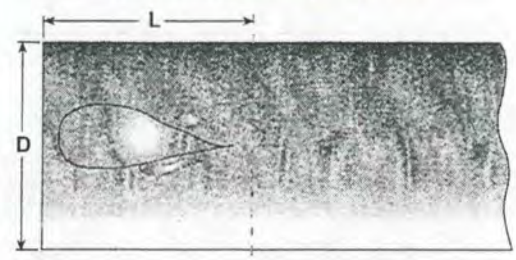
The system that delivers binder to the drum mixer includes a heated storage tank, a metering pump and a visual display for monitoring binder flow. The accuracy of this system is critical for successful production of hot mix asphalt.

Spiral Combustion Flights



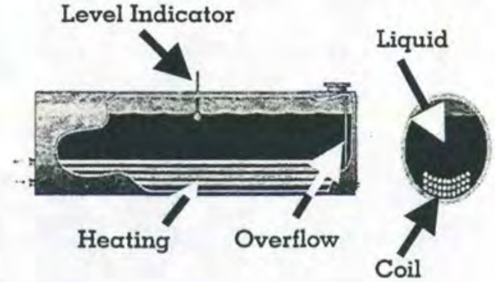
Spiral Flight

Combustion Zone Length to Diameter Ratio



Combustion zone
length = diameter of dryer

Horizontal Asphalt Tank Showing Hot Oil Pipes



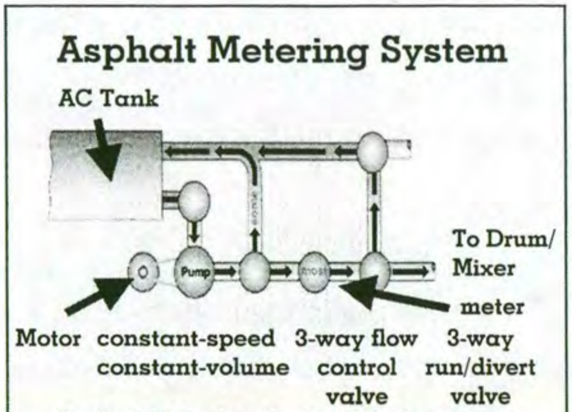
To ensure that aggregates and binder are always mixed in proper proportions, the aggregate weighing system and the binder metering system are interlocked. When the flow of aggregate into the drum mixer either decreases or increases, the flow of binder into the drum automatically adapts to the change.

During plant operation, the inspector will notice the visual display of the two systems do not give the same reading. Why the discrepancy?

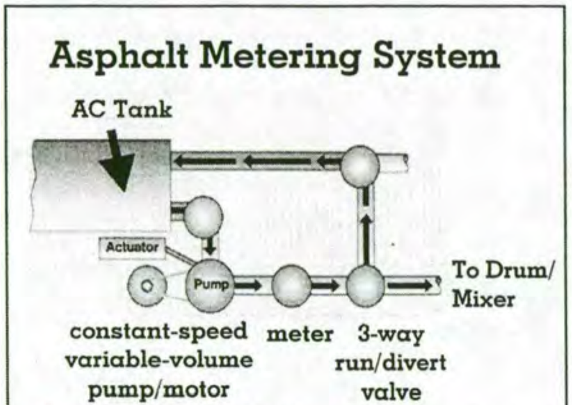
Very simple. The weigh bridge measures the combined weights of both the aggregates and the moisture the aggregates contain. The proportion of asphalt binder introduced into the mix, however, must be based on the weight of the aggregate alone. For this reason, it is important to know the moisture content of the aggregate being used.

In addition to the other features, most drum mixers are mounted on adjustable jacks that are used to control the drum's angle of tilt. A steep tilt forces the aggregates to pass through the drum mixer more quickly than a gentle tilt. Jack adjustments are one of the ways in which the length of time for heating, drying, and mixing can be controlled.

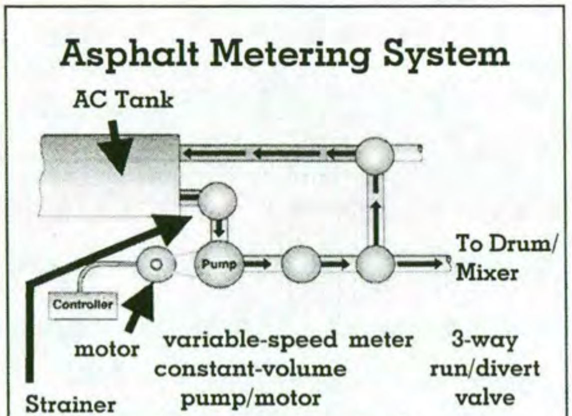
Another important component of the drum mixer is the dust collection system. There are several types of dust collection systems used in HMA plants; however, all have the same purpose: to capture as



Asphalt Metering System for drum-mixer plants with constant speed constant volume pump and flow control valve



Asphalt Metering System for drum-mixer plants with constant speed, variable volume pump



Asphalt Metering System for drum-mixer plants with variable speed, constant volume pump much as possible of the dust in the drum exhaust. This particular plant used a bag house, which gets its name from the hundreds of fabric bags inside it.

Dust collected in the bottom of the bag house is piped back into the drum as needed, for use in the mix.

When the drum mixer finishes its work, it discharges the hot mix asphalt from an outlet at its lower end into an elevator, which carries the fresh mixture to the top of one or more storage silos.

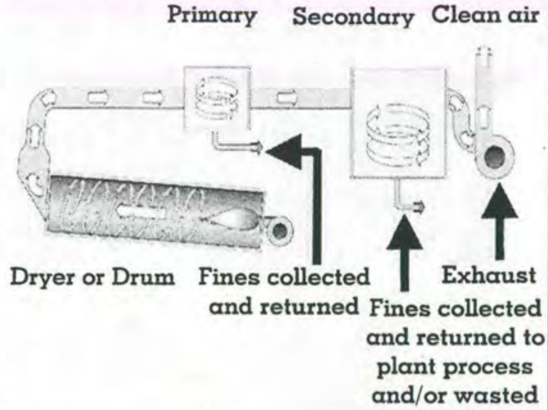
The silos keep the mix hot until it is hauled to the job site.

Gates located at the bottom of the silo discharge measured amounts of material into trucks for delivery.

Because a drum mix plant produces a steady stream of HMA, it is important that enough trucks and pavers are employed to use the volume of mix that the plant produces. Too few operational trucks or pavers can force the plant to halt operations, interfering with smooth flow of production needed to maintain mix quality.

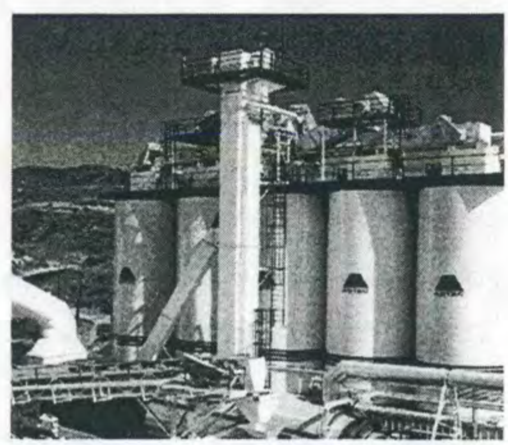
The nerve center for plant monitoring and control is the control van or trailer.

Primary and Secondary Emission Control Equipment

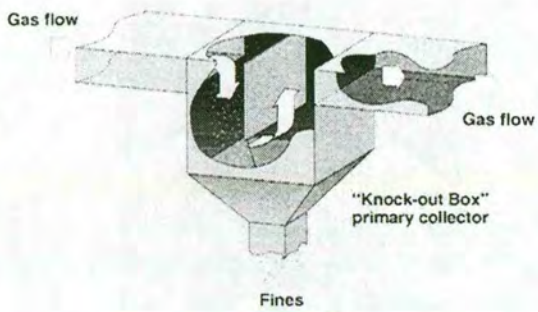


Twin Silo System

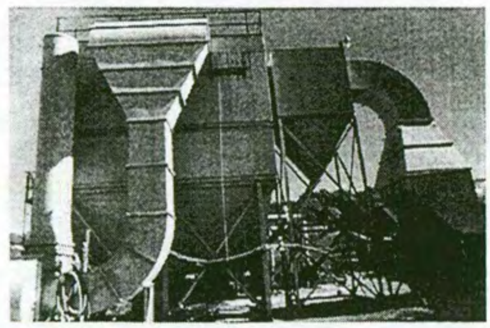
Multiple Installation



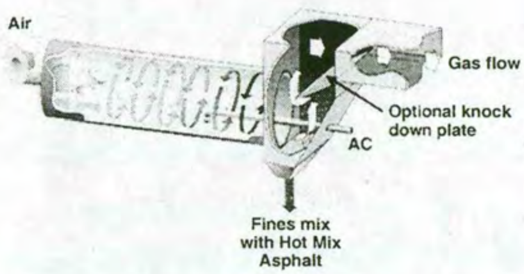
Knockout Box Showing Gas Flow, and Dust Fallout



Knockout Box installed prior to Baghouse

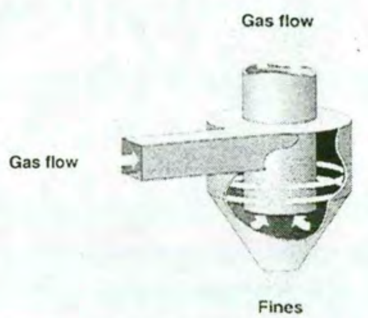


Discharge Housing functions as a Knockout Box

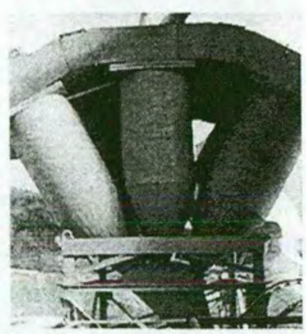


Vertical Cyclone

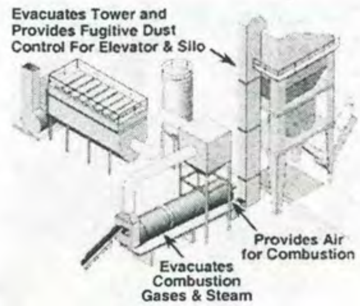
How a Single Cyclone Works



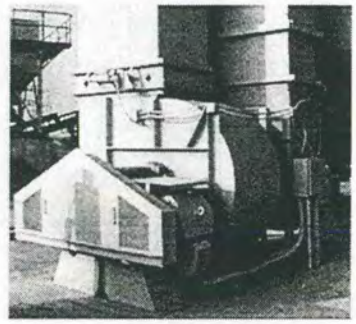
Multiple Cyclone



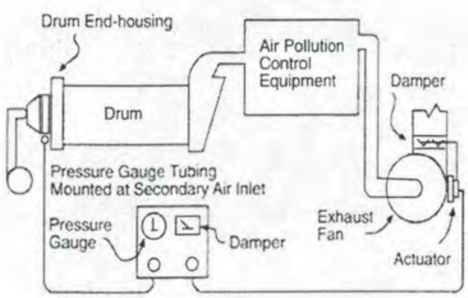
Jobs of the Exhaust Fan in the Plant Process



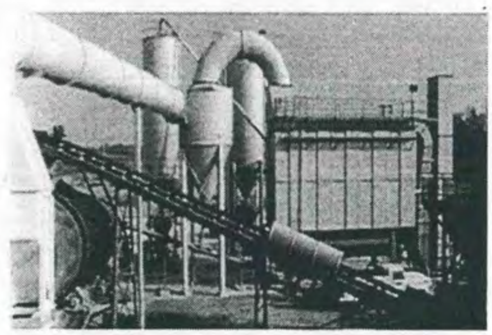
Fan with Damper on Baghouse on Hot Mix Facility



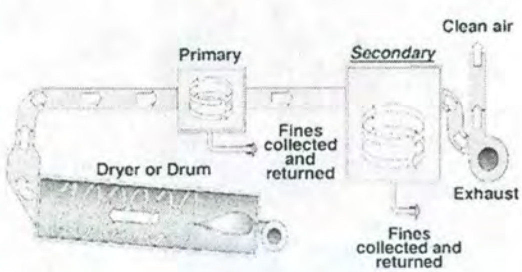
Automatic Damper Controls



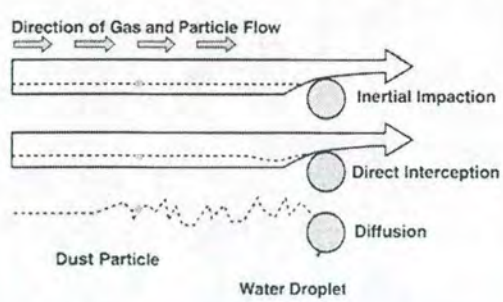
Primary Collector with Common Screw Conveyor



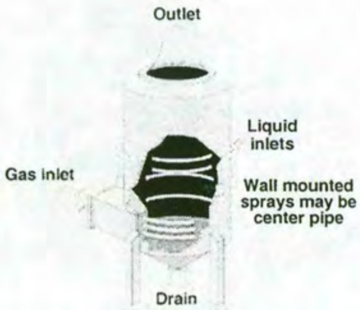
Primary and Secondary Equipment



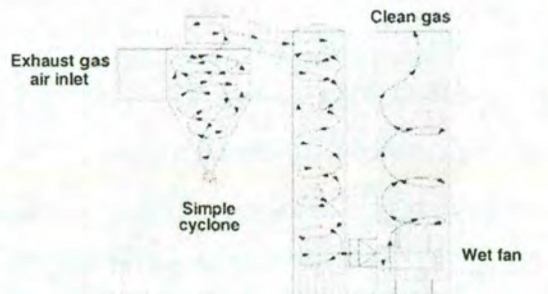
Mechanisms for Water Droplet Capturing a Dust Particle



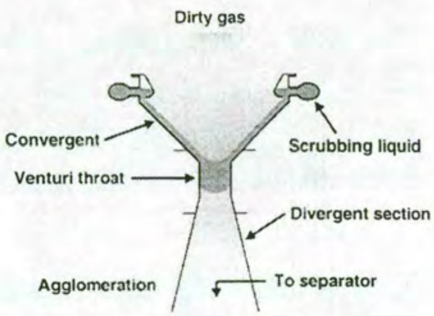
Centrifugal Washer



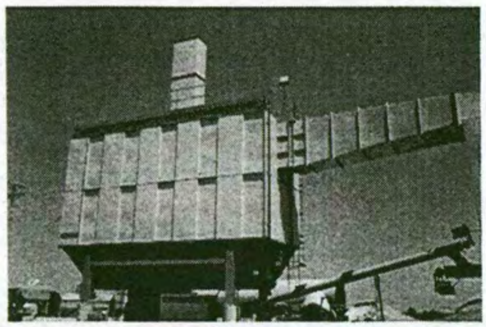
Wet Fan System



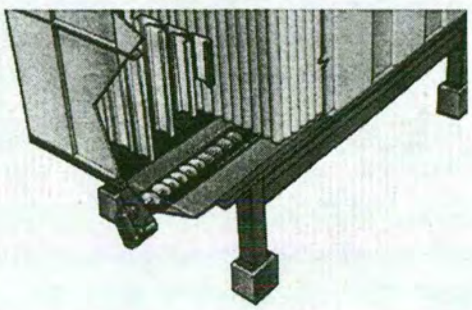
Schematic of Venturi Scrubber



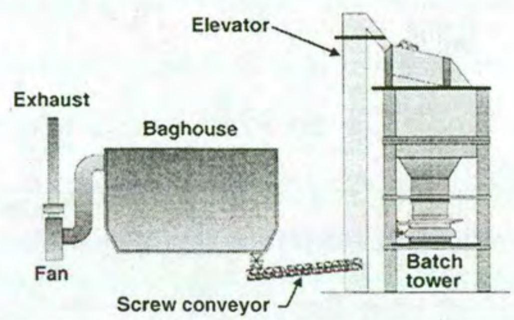
Pulse Jet Baghouse



Collecting and reusing Baghouse Fines



Baghouse Fines Going by Screw Conveyor to Elevator



It houses a full range of equipment needed to keep an eye on everything from aggregate and binder feed rates to mixture temperature and surge bin weights.

Having monitors and controls in a central location is an advantage of plant automation. It is an advantage that makes the inspector's job easier and allows plant personnel to react quickly to malfunctions and imbalances.

However, computer readouts and visual displays are no replacement for a sharp pair of eyes and a solid knowledge of plant functions and conditions. In short, automation can never replace a competent plant inspector.

In Review:

A HMA drum mix plant consists of several coordinated components; stockpiles and cold bins that store the aggregate, a cold feed system that proportions the aggregate onto a conveyor, and weigh bridge that monitors the rate of aggregate feed.

The conveyor feeds the aggregates into a drum mixer where they are heated, dried, combined with binder, and mixed together into a uniform paving mixture. A dust collection system reclaims mineral dust from the drum exhaust. From the discharge

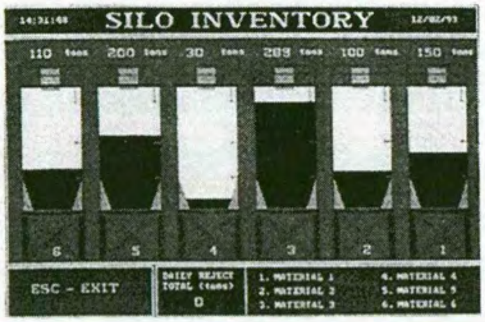
Portable Self-Erecting Silo

Computerized Truck Loadout Terminal

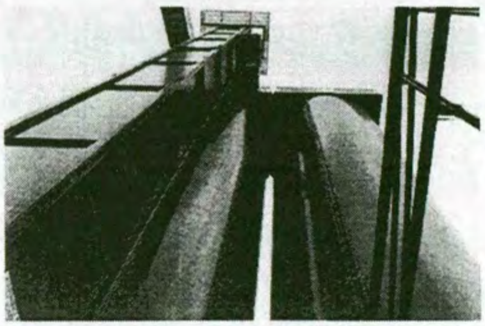
Modern, Computerized Drum-Mix Control

Stationary Five Bin
Silo System

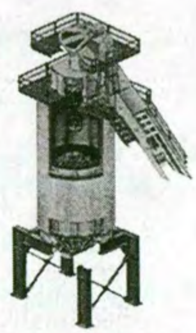
Modern Silo Control Screen



Bucket Elevator Feeding
Storage Silos

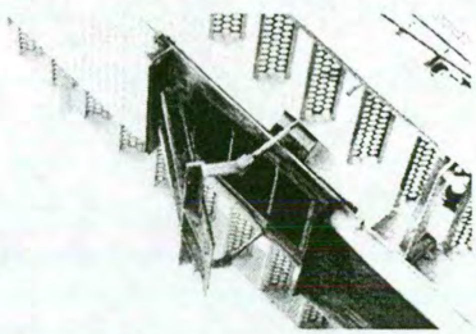


Drag Slat Conveyor



Slat Conveyor Feeding Silos

Drop-Out Chute in
Slat Conveyor



of the drum, conveyor carries the finished hot mix to the top of a storage silo.

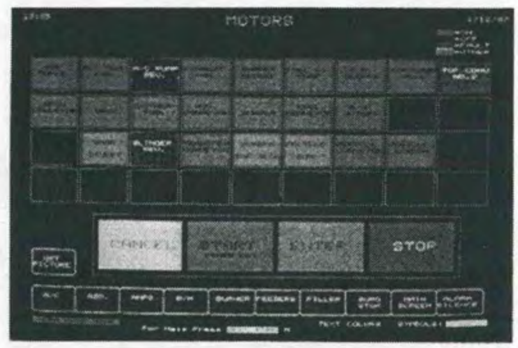
Plant systems and material conditions are monitored from a central locations, ensuring balanced and uniform plant operations.

Of course, drum plants vary in size and configuration, but their functions are essentially the same. With little modification, the points presented in this short program will be applicable to almost any plant you inspect.

We will be talking about recycling of hot mix asphalt throughout this course. Drum mix plants do recycling by modifying the plant to handle recycled material. It will be discussed in detail later.

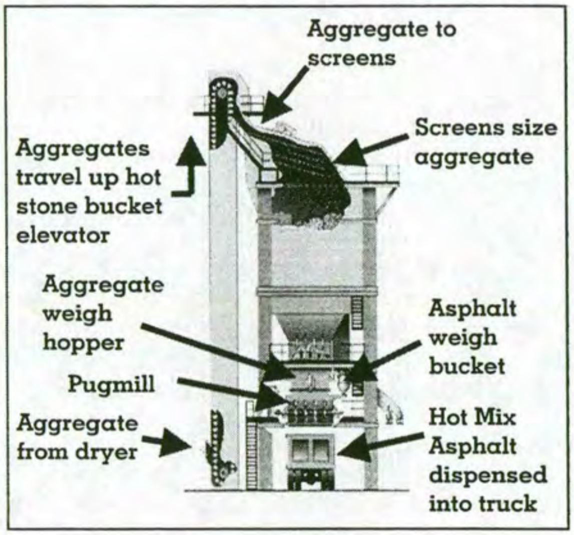
"Touch Screen" Control System with Manual Backup

"Touch Screen" for Motor Control



BATCH PLANTS

The second type of plant we want to discuss in detail is the batch plant. It is commonly used in Iowa and is especially useful in a permanent setup where several different mixes may be needed each day.



The general functions of a batch plant are the same as a drum mix plant. Inspection responsibilities are very similar, but the process of putting the binder and aggregate together is different. This affects the drying, adding binder, and mixing parts of operation.

Vertical Bucket Elevator on Batch Plant

Aggregate storage takes many forms. The proportioned aggregate is fed to the dryer by means of the cold feed belt. Somewhere in this area is where you must take the aggregate gradation sample. The frequency of this test is found in I.M. 204, and presently calls for three samples per lot.

Angled Bucket Elevator Batch Plant

The dryer is the first major difference in the batch plants. You will recall that the drum mix dryer has the burner at the top or inlet end to keep away from the binder. In the batch plant, no binder is added at the dryer so the burner can be placed at the lower or discharge end.

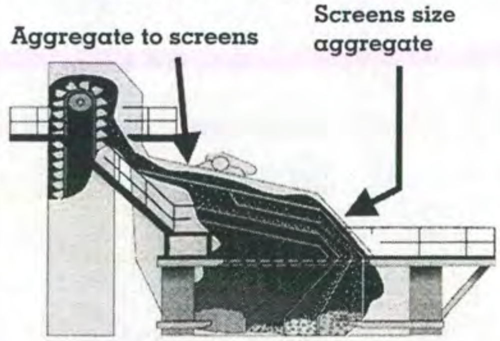
The heated aggregate is discharged into an elevator, which takes the hot material up into the overhead "hot bins". There are pollution control systems on the dryer to carry off the exhaust.

Batch plants are designed with a screening unit at the top where the hot aggregates are screened into various sizes and put into the hot aggregate bins. One of the benefits of the batch plant is that the operator can now batch out whatever mix is called for since each batch can be different. This is very useful at a plant doing commercial work. If this is occurring, you need to be aware of what is happening so you can keep track of the materials you are getting on your project.

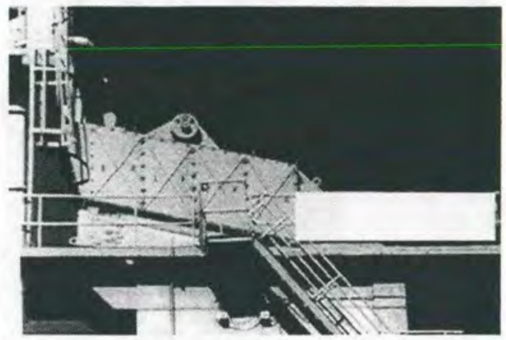
We have taken you through the batch plant operation using the example of a plant where the hot aggregate is screened into sizes and recombined through separate hot bins. Fortunately, this is not the usual plant setup in Iowa. Most batch plants here use the aggregate gradation just as it comes from the dryer. It is already proportioned at the cold feed and comes all the way through the plant in a single line. The hot bin area will be either a single bin or the operator will have a separate for our use that bypasses the screening unit. This brings the aggregate into the weigh hopper with only one weight to be concerned with.

We are now ready for the asphalt binder to be brought into our batch.

Screen Deck Area



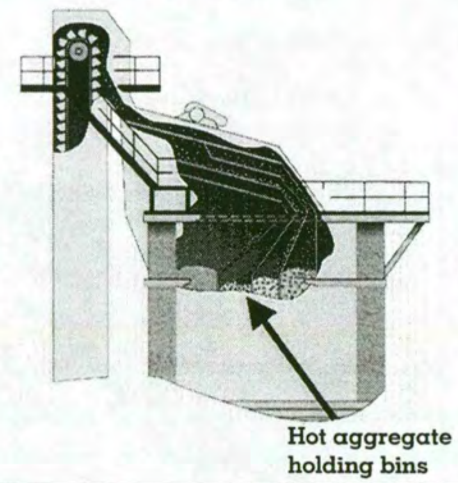
Inclined Screen



Horizontal Screen

Heated asphalt binder is piped from the binder storage tank into the asphalt binder weigh bucket. One batch worth of binder is weighed out and at the proper time in the batching sequence, will be pumped into the pugmill. The asphalt binder is proportioned by a scale weight for each batch.

Hot Bin Area

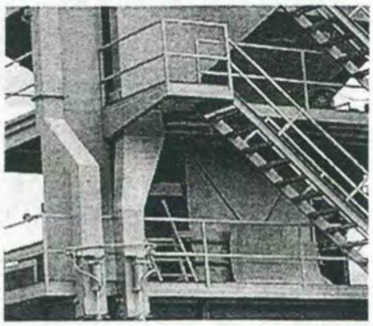


As the pugmill is mixing the aggregate, asphalt binder is sprayed into the chamber. As the batch is in its mixing cycle, the plant is filling the weigh hopper with aggregate for the next batch.

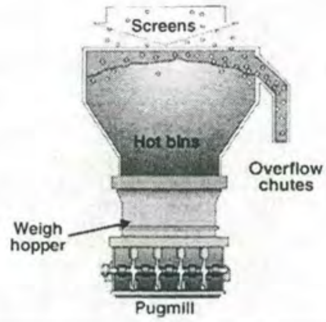
There are specifications governing pugmills. These requirements include twin shafts, a paddle-to-side clearance not more than ¾ inch, and others. You need to review current specifications for the equipment requirements.

Recycling is also done at batch plants and usually involves modifying the plant for the recycled feed and adding to pollution controls.

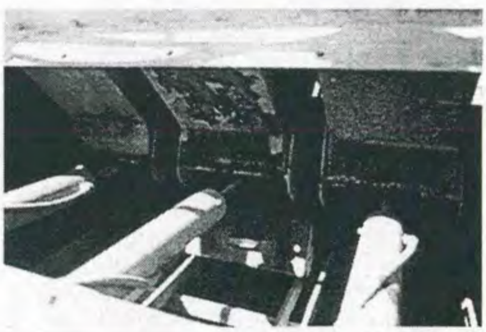
Overflow Chute with Shut-Off Gates on Ends



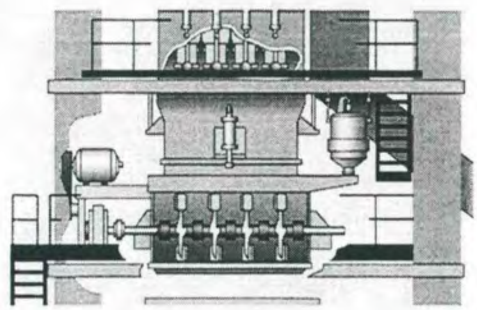
Bin Levels



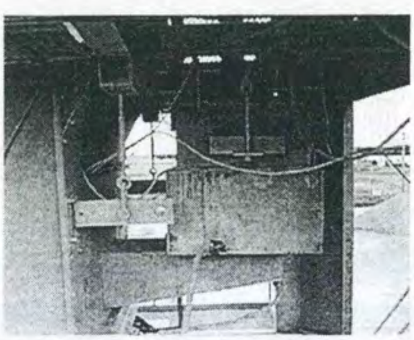
Aggregate Sampling at Supply Gate



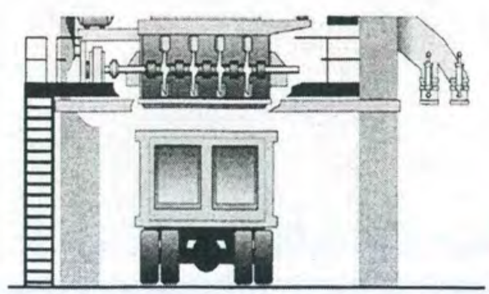
Asphalt Weigh Bucket



Asphalt Weigh Bucket Suspended on Load Cells

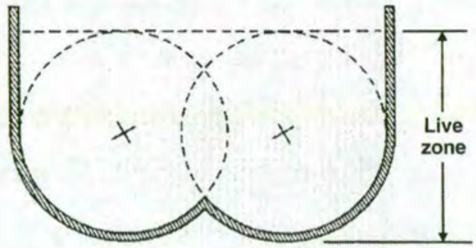


Pugmill

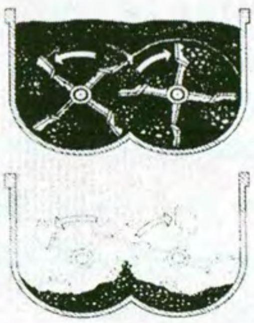


Inside of Pugmill

Live Zone in Pugmill

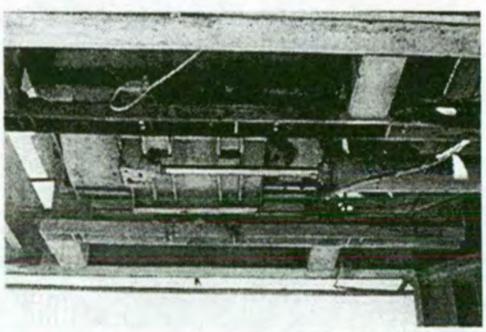


Overfilled and Underfilled Pugmills



Timing Gears for Pugmill

Discharge Gate for Pugmill



"Table Top" Computerized Batch Automation

CONTINUOUS PLANTS

There is a third type of HMA plant called a continuous plant. A continuous plant has the dryer and hot aggregate bins similar to a batch plant. Instead of weighing and mixing in batches, the continuous plant feeds the aggregate and binder into the pugmill in a steady flow. The pugmill mixes the materials as they move through, discharging the final mix into a weigh hopper or a storage silo.

The aggregate and binder flows are both going on continuously, so they are a metered flow. The aggregates will come into the pugmill from a calibrated belt and the binder will come through a calibrated pump.

The method of proportioning materials may be a little different, but a good mix is still the result when proper operations are done.

We still have two areas of plant operations to consider in the making of the mix. One is what to do with the mix for storage prior to sending it to the road, and second, how to control the pollution that results from the drying and heating process.

MIX STORAGE

Mix storage may or may not be necessary. Some batch plants only make the number of batches required for truck delivery. The mix is batched and deposited directly into the trucks.

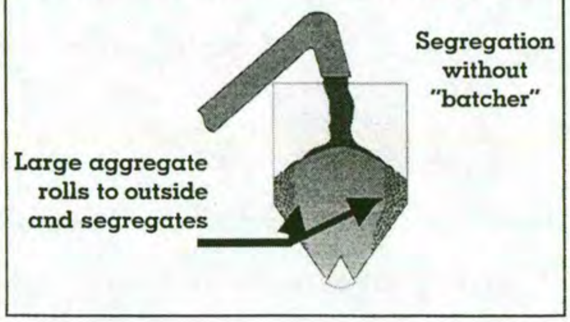
Drum mix and continuous plants, on the other hand have a continuous flow of mix, so if a truck is not available for immediate delivery, the mix must be placed in hot storage. This is accomplished by means of a hot elevator and storage silo.

Hot mix from the drum is raised by means of the hot elevator to the top of the storage silo. At the top of the silo is a small storage unit called a "gob hopper". This stores smaller quantities of hot mix so it can be dropped into the storage silo in a "gob". This helps cut down the segregation that might occur if there was a steady stream of mix falling into the silo.

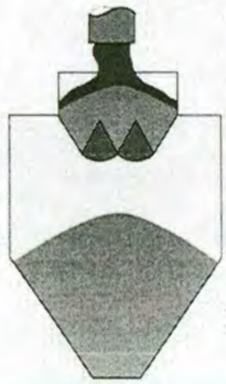
Many silos have internal baffles that direct the flow of mix as it passes through. This is another way to cut down the segregation of the mix. Many problems of segregation on the roadway can be traced back to the elevator and storage silo.

Part of your job as plant inspector is to know what equipment is being used, whether it complies to specifications, how it is supposed to work, how it is

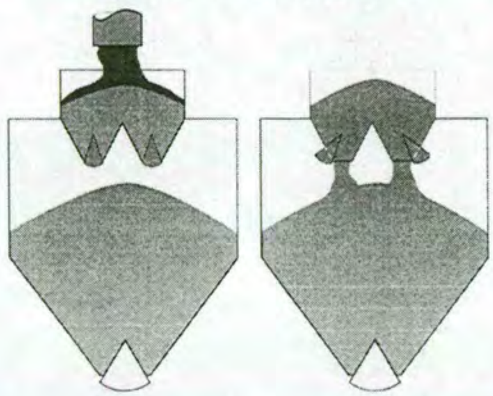
Segregation Occurring in Silo w/o a Batcher or Gob-Hopper



Center Drop Batcher



Split Feed Batcher



working and where to look for problems. Most of this should be checked out before paving begins.

You see here a storage silo, which is fed by a slat elevator. Slat elevators are not all the same and are very much different than a bucket elevator.

If you are pursuing a segregation problem and someone asks what the discharge of the silo looks like, the gate is rectangular, and if you look at it when closed, that is all you know. The actual silo discharge is not rectangular in this case. You must get out and observe.

Many silos, especially at contractor's portable plants, are equipped with a weigh hopper at the bottom. The weigh hopper eliminates the need for separate truck scales.

POLLUTION CONTROL

Pollution control equipment is necessary to eliminate exhaust dust and smoke from the operation.

Whatever process or equipment is used at the plant to remove the waste matter from the exhaust, the intent is the same. Nobody ever said bag house fines were easy to waste. They are hard to handle and dispose of, but it may be necessary. Sometimes a separate "bag" is made to hold the fines prior to the final disposal.

USE OF RECYCLED ASPHALT AT HMA PLANTS

Recycled asphalt pavement, RAP, is an option on some projects.

The following factors must be evaluated:

1. Quality of the aggregate in the old pavement
2. Characteristics of the old asphalt binder
3. Gradation of the aggregate in the recycled material
4. New aggregates to go with the recycled product

All mix design criteria must meet the appropriate specification.

There are two types of recycled plants that currently meet our specs. The first one is the Drum Mix Plant. The drum has been modified to allow the RAP to be introduced near the middle of the drum just below the end of the flame. The heating and mixing take place between here and the discharge end of the drum.

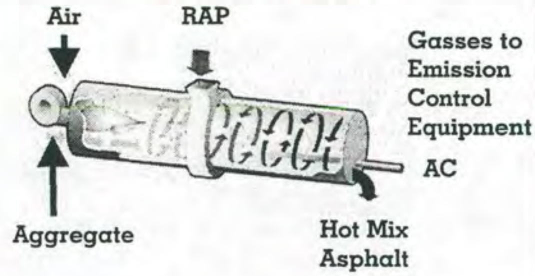
The second type is the Batch Plant:

1. The new binder is weighed on a scale
2. The virgin aggregate is weighed in the weigh hopper
3. The RAP is then either weighed in the aggregate weigh hopper or fed into the hot elevator over a weigh belt

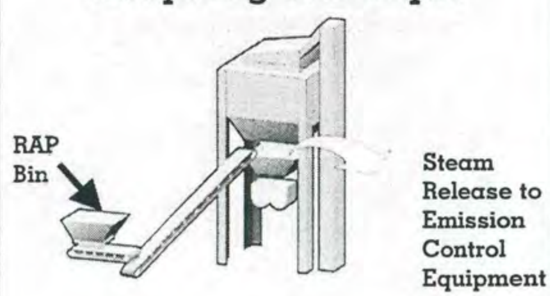
Types of Recycled Plants

- Drum Mix Plant
- Batch Plant

RAP Collar on Parallel-flow Drum-mixer



"Weigh Box" Batch Facility Recycling Technique



4. Drying is accomplished by the heat transfer method during the dry mixing time
5. Wet mixing occurs when the binder is weighed and added to the mix.

On projects requiring removal of the old HMA pavement, the contractor is allowed to select the method of removal.

RAP, whether previously processed or not, shall be sized by passing through a 1 ½ in (37.5 mm) in flat sieve or a 2 in (50 mm) tilted vibrating screen before deposit onto the feed belt. This may be accomplished by passing the RAP through a larger sieve with an in-line clump breaker in conjunction with the cold feed RAP bin. This assures the RAP will be in smaller pieces and will heat and mix properly without having large clumps in the mix.

A vibratory screen can be used in the prescreening process. The oversize from this may be reprocessed or broken up for use in the mix.

The specification requirements for proportioning require:

1. Dual cold feed belts (virgin aggregate and recycled)
2. Weigh belts must be interlocked to deliver material properly
3. There must be individual weight recorders of the total RAP being delivered

4. The weigh belts must be hooked to a totalizer
5. The totalizer must be interlocked to the binder delivery system so the proper amounts of binder and aggregates are delivered correctly

There are two common methods of entering data into the plant electronics. One of the latest methods is using a computer console. Other models use vernier settings. Important things to know are:

1. How the moisture settings work
2. How the percent of binder is figured
3. What amount of binder content is in the RAP and how much new binder you need to add into the mix

The intent of the interlock system is to assure that the mix remains proportionate. Some plants are interlocked but will shut down if the proportions are not maintained. Using a flow indicator switch in the cold feed stream provides an acceptable addition to the interlock system to meet our specs. A couple of different examples of interlock systems are:

1. In computer plants there are alarm systems
2. When there is a recycled belt speed control sensor, if the flow of RAP is cut off, this will shut the whole operation down

The other type of plant where RAP is used is the batch plant. The RAP is fed through a bin onto a cold feed belt, which is the same procedure as in a drum mix system.

One way that the RAP is added can be in the weigh hopper. It is weighed as a separate increment of the total batch weight. This allows no preheating as the drying is done by the heat transfer method.

The other method that is used is to be fed into the hot elevator. When this method is used, the RAP must be proportioned over a weigh belt including a totalizer and flow rate meter. Air pollution is a major concern with recycling. The EPA and DNR are responsible for the plant's clean air certification program. They also monitor plant performance regarding the air pollution. The plant inspector is responsible for informing the contractor and the engineer when air quality violations are suspected.

Air pollution from the drum plant may be effected by:

1. Production rates
2. The percent of recycled materials in the mix
3. The amount of drying that is required

Let's go over a couple of items that you need to know: How to figure the correct mathematical percentages of both the RAP and the virgin material to compensate for the asphalt binder in the RAP material.

MIX SEGREGATION

Mix segregation is a very serious problem. The first place that it may occur is at the drum discharge chute on a drum plant. If the drum does not center in the chute, segregation may occur. This can be detected by watching the discharge from the drum. It can also be seen by checking the mix going up the hot elevator. Generally, any segregation from the drum discharge will be evident as the material is carried to the silo. Some of the elevators are enclosed but there is generally an access area near the bottom that can be opened.

The next place that segregation can occur is at the batch hopper above the silo. Materials coming up the hot elevator are temporarily stored and discharged in batches. If the gates do not function properly, material dribbles into the silo and may tend to segregate as a cone of mix develops in the silo. With close inspection, you can see the gate cylinders working. On computerized plants, the batch hopper function is shown on the video screen.

On some silos, the direction the gates open on the batch hopper is the same as the discharge gate opening direction on the bottom of the silo. This may be a source of a segregation problem. If the mix is segregated at the time of delivery into the silo, it will probably be segregated when discharged into the truck.

All silos must be equipped with low bin indicators. Mixes should not be pulled down below the level indicator as segregation may occur in the lower discharge cone of the bin. Be sure you know which light is the bin level indicator.

It is important that the truck driver move the truck between dumps from the silo. This spreads the mix more uniformly over the truck box. When the truck is left in one spot to fill, excessive coning of the mix occurs. This causes segregation.

Twin discharge gates help to distribute the mix across the truck box and may reduce the segregation that can occur at this point. You should again ask yourself if what you see here represents the whole story of the silo discharge, or is there a different shaped opening above these gates?

Most new drum mix plants have weigh silos. Instead of the separate weigh hopper, the entire silo is weighed on load cells.

Note: Check the exterior shape of the silo. Specifications do not allow square, so you have two options to check:

1. Manufacturer's literature
2. Go look for yourself

One of the foremost problems in HMA paving is segregation of the mix. Some of the causes are from the paver, but they also can be traced back to the plant. Every point in the hot mix handling process can be a point of segregation. If your road inspector advises you that there are segregation problems, check the plant from stockpile to exit gate for possible problems and solutions.

Case Study:

A new plant with weighing silo looks good, but has problems. The drag chain elevator shape started segregation. The gob hopper discharge has two parallel gates, which are parallel to the two silo discharge gates, which aggravated segregation. In this case, the segregation on the road changed sides of the lane, when the truck loaded heading the opposite way under the silo. Remember there are things that you can do to spot segregation problems. The responsibility for solving segregation problems rests with the contractor.

In short, you have seen a quick exposure to a lot of material in a short period of time. You have a responsibility to the contractor and to yourself to look, ask, and listen. Every day at the plant should be an education.

PLANT CALIBRATION

INTRODUCTION

We are going to cover several items pertaining to the hot mix asphalt plant and the calibration of these plants. We are not going to try to make you experts on the calibration procedures, but we are trying to give you an insight into this.

1. Before the job starts, all material proportioning equipment must be calibrated and checked for accuracy.
   A. The calibration is the responsibility of the contractor and will be witnessed by the District Materials Office. The contractor must furnish:
      1. The people to calibrate the HMA plant
      2. The scales
      3. The test weights
      4. All equipment required to calibrate
      5. The contractor conducts the calibration and prepares the paperwork.
      6. Runs the moisture contents on each aggregate if no plant inspector is present
   B. The certified technician should be present during the calibration:
      1. To become familiar with the contractor's equipment

2. To learn how all the settings are made
3. It is also a good time to discuss the job mix or any other items.

C. Prior to the calibration, the following items should be checked, particularly for portable setups.
   1. Is there adequate footing for equipment such as the storage silo, the binder tanks, and the cold feed bins?
   2. Is the equipment setting level? Binder storage tanks that are not set level can give inaccurate tankstick readings.
   3. Are all the bins in good shape? Make sure all the parts are in place that are required.
   4. Are there ground rods where they are needed?
   5. Do all the stairways have handrails where necessary?
   6. There should be covers or other protection on pulleys, belts, and drive mechanisms. Make sure they are in place.
   7. If something doesn't appear right, discuss it with the contractor.
   8. The main thing is to make sure you feel safe about the equipment and the work you must do around it.
   9. Another item to watch for is unequal settlement around the bin footings. Rain and heavy truck traffic may have an effect on this throughout the job.

D. The equipment that needs to be calibrated is:

1. Aggregate cold feeds, which are basic to all HMA plants
2. The asphalt binder meter
3. The weigh belts
4. The batch scales
5. The storage silo weigh hoppers
6. Possibly, hydrated lime feeders if required

Aggregate cold feed bins determine the gradation of the mix. There must be a separate cold feed for each material in the mix.

There are three major types of bin delivery systems:

1. Fixed gate variable speed
2. Fixed speed variable gate
3. Adjustable gate with variable speed

On plants that use a fixed speed variable gate opening cold feed, to change the amount of material coming through the gate, you can change the height of the gate opening. The lever to change the gate opening could be vertically graduated.

In some cases, there will be no graduated scale. The gate opening has to be measured with a ruler.

The size of the gate opening should give a uniform delivery. The flow should be checked at calibration time, to eliminate such things as a choppy delivery, that could happen with a wet sand or gravel, and to assure that you will get a representative sample from the cold feed.

The master control can not be moved during the calibration of the individual feeder controls. If moved, your answers would not be correct. To change the speed of the individual cold feed, the control setting is changed. The change would be reflected in the tack readout. The calibration settings may be noted by the numbers on the dial, the tack, or by the digital readout.

If you would change the setting of the master control, it will change all the individual feeders in the same proportion. This can be used to make changes in the production rate of your plant. It also allows the delivery of the correct percentage of each material, as the mix design requires, for the tons per hour (TPH) the plant is set for.

It is acceptable to use the weigh silo to calibrate your plant once you have calibrated it to meet the required specifications.

After the plant calibration is completed, a calibration form must be filled out. Some of the things needed on the report are:

1. The county, project numbers, and the date
2. The contractor and plant location
3. The mix type, class, and size

4. The material identification and % of material in the mix
5. The moisture content of the material at calibration time
6. The bin number
7. The sampling point

There will be a calibration form for each aggregate being used in the mix.

Depending on the plants level of automation, a contractor's representative may be required to draw up a graph using Table T-101, which is in the asphalt section of the IMs, to get their standard plot points. At that time, they should also plot their calibration points. Uniform delivery should give you a straight line.

The graph points come from two different items.

1. Your calibrated points, which are plotted first
2. Your standard points that can be obtained from the T-101 or they can be calculated

The following information needs to be on a calibration graph:

1. Materials represented
2. The bin number
3. The gate setting
4. The moisture of the aggregate
5. The project number
6. The date

7. The county and the contractor

The Table T-101 is used to determine the lb. (kg) per minute from the percentage of material used and the projected operating ton (Mg) per hour. For example,

We have a 30% material running at 200 TPH or ton/hr.

The answer is 2,000 lb./min (1,000 kg/min).

This would be one of our standard plot points on our calibration graph. These are standard delivery rates.

Now let's figure the answer by the calculation method.

English:

$$\frac{\text{Ton} \times 2000\ (\text{lb./ton}) \times 0.55}{60\ (\text{min/hour})}$$

Metric:

$$\frac{\text{Mg} \times 1000\ (\text{kg/Mg}) \times 0.55}{60\ (\text{min/hour})}$$

This is the same answer as from the T-101. Knowing how to calculate this is important in case you lose your plant manual.

Your plotted points determine the delivery settings at the bottom of the graph. Be sure the operating range is covered by the calibration. When a project starts, the plant inspector needs to check and be aware of the following items:

1. Check the gate settings and make sure they are correctly set for the planned TPH production rate.
2. Make sure the gates haven't slipped and that no buildup has occurred at the gate openings.
3. Make sure the right material is in the correct bin.

Weigh belt on a drum mix plant.

1. These plants rely on a weigh belt that is interlocked with the HMA delivery system.
2. This weighing system weighs all material crossing the weigh bridge.
3. The belts should be run empty prior to calibration to make sure it is free of hang-ups and to warm up the electronic system.
4. During actual plant operation, continue to check for rocks that might get wedged in the weigh bridge area.

The weigh belt totalizer records the tons (Mg) of material that goes across the weigh belt. On the lower part, there are two controls labeled fine zero and span. These settings will be noted on the calibration form. The span setting should not be changed after calibration because it is directly related to the angle of the belt.

On the weigh belt calibration, to get the percentage of error, you divide the difference by the truck weight.

The weigh belt is calibrated by comparing the weight indicated by the belt scale totalizer with a weight from a certified scale.

Once the totalizer is calibrated on this type of plant, the weigh belt can be used to calibrate the cold feeds rather than a platform scale.

A calibrated weigh belt can also be used to make a single set point calibration of cold feeds when the plant has a digital readout system.

The advantages to this are:

1. Fast calibration
2. No graphs have to be drawn
3. The ton per hour adjustment is done by the master control

The disadvantage is that any mix change requires a recalibration.

Some binder meters correct to 60° F gallons, but others do not. If they don't , a correction factor from the chart T-102 (found in the asphalt section of the IMs) must be used.

A binder meter is calibrated by comparing the metered gallons (liters) with the actual weighed quantity delivered. It is important to remember to use the mass per gallon (liter) of the binder that is on the delivery ticket, to figure your weighed metered gallons (liters).

The weigh belt with a moisture compensator adjustment controls the binder pump.

1. If the compensator is set higher than the actual moisture, the weight over the belts has less moisture than indicated, meaning there is more aggregate, which results in the binder content being too low.
2. If the compensator is set lower than the actual moisture, it has just the reverse effect, giving you a binder content that is too high.

Remember, moisture must be taken on both the virgin materials and the RAP product if being used in all drum mix plants.

In batch plants, the aggregate and binder weigh hoppers could be connected to dials or digital readouts. The calibration of scales is done by the contractor and witnessed by the District Materials Office.

Next, we are going into a section pertaining to weighing for pay quantity. Truck scales must meet:

1. The requirement of the Iowa Department of Agriculture
2. Be certified by a bonded scale repairman
3. They must be certified prior to use for the calibration
4. They must be certified if used to weigh mix for payment

As a certified technician, you need to check and document:

1. One daily sensitivity check
2. One daily verification weighing for platform scales (which is a check on the same scale). The verification mass shall not be different than the initial mass by more than 0.1%.
3. One check weighing, which is a check on another certified scale with the check mass being not different than the initial mass by more than 100 lb. (45 kg) allowing for fuel used. One additional check weighing is required for project quantities exceeding 5,000 tons (4,536 Mg).
4. If there is a problem with the check weighing, a plant should have 50 lb. (22.68 kg) of test weights for accuracy checks. Recalibration may be necessary if problems persist.

The silo can be recalibrated by applying weights as in the batch plant calibration or by checking the indicated mass in the hopper against another certified scale.

To check for sensitivity, hang a weight on the weigh hopper. By hanging this weight, there should be a noticeable movement to attain sensitivity on your individual scale.

To run a scale operating tolerance, the contractor has put the arrows on his scale to show where the tolerance range is required to be. To be in compliance, the scale must weigh in this range.

Automatic or semi-automatic weighing (Procedure 1 or 2) shall be used for weighing mixture when furnished in quantities of 10,000 ton (Mg) or more from a single source per project.

Automatic weighing equipment shall be self balancing and shall include automatic mass recorders. All tickets shall be printed automatically with the net mass and all masses needed to determine total net mass.

For semi-automatic weighing, the weighing equipment may be self balancing or manually balanced. Equipment shall include an automatic mass recorder that will not print until the equipment is balanced and which prints the gross mass or the batch mass and number of batches. For weigh hoppers, the printout shall include the empty weight after each discharge.

WEIGHING EQUIPMENT

HMA plant scales will be proportioning scales or pay quantity scales. The same scale may sere both purposes in a batch plant.

1. Proportioning Scale- used to proportion a part of the material into the mixer. Examples are the Ramsey weight belt in a drum mix plant or the weigh hopper scales in a batch plant.

2. Pay Quantity Scale- used to measure a weight for pay quantity. Examples are the truck platform scale to weigh loaded trucks or a storage silo discharge weigh hopper.

A plant inspector will generally be involved in the accuracy and sensitivity checks on scales. Examples are as follows:

DRUM MIX PLANT

***Ramsey weigh belt and binder delivery pump**
Accuracy = 1.5%
Sensitivity = no specification
Article 2001.22 F

*** Pay Quantity Scales**
Same as batch plant below.

BATCH PLANT

Batch plant aggregate scale may need to meet pay quantity scale requirements if counting batches for pay quantity determination.

***Proportioning Scale**
Accuracy = 5 lb./1000 or 5 kg/1000 (0.5%)
Sensitivity = 0.1%, 1 graduation and not more than 20 lb. (10 kg)

***Pay Quantity Scales**
Accuracy = 2 lb./1000 or 2 kg/1000 (0.2%)
Sensitivity = 0.1%, 1 graduation and not more than 20 lb. (10 kg)

There will be situations where the proportioning equipment acts as the pay quantity scale. This occurs in a batch plant that discharges mix directly into the trucks and the pay quantity is determined by counting the number of batches and multiplying by the weight per batch on the proportioning scale. In that case, the proportioning scale and pay quantity scale are one and the same. This is why batch plant scales may be required to be accurate and sensitive to the tighter limits. The plant inspectors should assure themselves at time of calibration that they know which scale systems are in use at the plant and what checks and documentation are required.

ACCURACY

SENSITIVITY

TOLERANCE

DEFINITIONS:
Scale Accuracy: A measure of how close the registered weight is to actual weight.

Example:	Actual weight	= 10,000 lb. (kg)
	Scale reads	= 9,980 lb. (kg)
	Difference	= 20 lb. (kg)
	20/10,000 = 0.002 = 0.2%	

If the example is a pay quantity scale it would comply with the allowable 0.2%.

Would it also comply with the allowable of 0.5% on a proportioning scale?

Scale Sensitivity: An indication of scale reaction of weight variation

Example:	Batch weight	= 10,000 lb. (kg)
	Scale graduations	= 10 lb. (kg)/grad.
	Wt. Needed to move scale	= 20 lb. (kg)
	Sensitivity	= 2 graduations

Does example comply with pay quantity requirements of not less than a weight equal to on of the minimum graduations and not more than 20 lb. (10 kg)?

Scale Operating Tolerance: A limit above or below the target weight, which is still acceptable.

Example:	Batch Weight	= 10,000 lb. (kg)
	Operating tolerance	= ±1%
	10,000 x 0.01 = 100 lb. (kg)	
	Batch = 10,150 lb. (kg) hopper should not discharge because it is beyond the 1% tolerance	

Or

Total weight of mix for day	= 100,000 lb. (kg)
Total weight of mix by proportioning scale	= 101,500 lb. (kg)
Not within 1% operating tolerance	

NOTE: Operating tolerances are set in the plant controls as interlocks, which prevent the plant from operating unless it is within the tolerances.

$ WEIGH FOR PAY $

1. HMA Basis of Payment

   Contractors are paid for HMA on a weight basis. HMA mixtures can be weighed over platform scales, in silos on load cells, in weigh hoppers, or by counting batches. We are going to review some of the weighing tolerances, checks, and requirements of truck tickets.
2. The Contractor shall provide a weight ticket for each load showing required weight information.
3. Scale Tickets

TRUCK SCALE TICKETS

Project Number

Date

Type of Material

Gross Weight

Tare Weight

Net Weight

Truck Number

Signature of Certified Weighmaster

The required data to be printed on the weigh tickets will vary according to the type of system (automatic, semi-automatic, or manual).

The GROSS, TARE, and NET weights are required on a scale ticket for the scale to qualify as automatic!!!!!.

4. Automatic or Semi-Automatic Weighing
   - A. For weigh hoppers, batch scales, or silos on load cells, all tickets printed automatically shall include the gross weight, tare weight of the material not discharged, net weight of material for each drop, and the total net weight for the load.
   - B. For Batch scales, the batch weight and batch count are to be automatically printed through the system, or calculated by a weighmaster with a semi-automatic system.
   - C. For truck platform scales, all scale tickets printed automatically shall include gross weight, tare weight of the truck, and net weight of the load. For semi-automatic weighing, the printer shall print the gross weight and the weighmaster shall conduct all

to one-tenth percent the batch weight on the fully loaded scales and observing the movement of the indicator. A properly sensitive scale will exhibit a visible indicator movement when so tested. If no indicator movement is visible, immediate corrective action must be taken by the contractor.

B. Truck platform scales**. Each scale should be checked for sensitivity initially and at least once each working day using a weight equal to 0.1% of quantity being weighed, or weight equal to one of the minimum graduations, but not more than 20 lb. (10 kg).

13. Use of Weighmaster

A. The specifications require a weighmaster for weighing HMA mixture for semi-automatic and manual weighing of trucks.

B. Weighmaster Oath**. To be certified, a weighmaster must sign an oath. Personnel desiring to become a weighmaster may obtain such forms from the Iowa Department of Agriculture.

14. Summary

The weighing equipment shall be accurate to 2 lb./1000 lb. or 2 kg/1000 kg of weight for determining pay quantity.

The weighing equipment shall be sensitive to a weight change equal to 0.1% of the quantity being weighed, but not less than a weight equal to one of the minimum graduations and not to exceed 20 lb. (10 kg).

**For more information see:

A. Construction Manual (3.50-new), Weighing Equipment for Determination of Pay Quantities

B. Iowa Standard Specifications 2001
Article 2001.07, Weighing Equipment and Procedures.

WEIGHING EQUIPMENT FOR HMA PLANTS SUMMARY

SCALE ACCURACY: A measure of how close the registered weight is to the actual weight.

At time of calibration

0.2% for scales and binder meters used to determine pay quantity (platform scale, silo discharge weigh hopper or batch plant proportioning scales when counting batches for pay quantity)

0.5% for proportioning scale (aggr. weigh hopper or binder weigh bucket on batch plants when not counting batches for pay quantity)

1.5% for all weigh belts and binder meters not used for pay quantities (drum mix plants)

During use:

Check weighing is used to confirm the accuracy of all types of weighing equipment. Check weighing is defined as a second weighing of the same load on another certified truck platform scale. A reasonable adjustment for fuel consumption is allowed. One check weighing is required the first day of production and one additional random check is required for projects exceeding 5,000 tons (4536 Mg). Check weighing must agree within the following tolerances:

0.3% for truck platform scales only

100 lb. (45 kg) plus or minus for all other weighing equipment

SCALE SENSITIVITY: How sensitive the scale is to a change in weight as indicated by the scale reaction to a small weight variation.

All types of weighing equipment, except weigh belts, must be checked at least once per day for proper sensitivity by placing a small weight on the fully loaded scale and observing the dial or readout for movement. The weight used for the sensitivity check is normally 0.1% of the quantity being weighed, however it cannot be less than one of the minimum graduations of the scale or more than 20 lb. (10 kg).

VERIFICATION WEIGHING: A second weighing of the same load on the same platform scale.

There is one additional check that must be performed daily when using a truck platform scale for pay quantities. A verification weighing involves weighing a loaded truck, driving the truck off the scale then back on the scale, and weighing it again. The verification weight should not be different from the initial weight by more than 0.1%.

PORTABLE SCALE REPORT

Owner ______________________________ **Date** ___/___/____

Address____
(Street)

____ **ZIP** ________
(City) (State)

Scale Make ____________________ **Model** ______________________

Capacity ____________________ **Platform Size** ____________________

Location ____
(County) (Township) (Section)

Quarry Name ____

Remarks: Was scale found to meet the specifications and tolerance set by the Iowa Department of Agriculture? ______________________________

If the answer to above is "no," did you make necessary repairs to bring it into specification and tolerance of the Iowa Department of Agriculture? _____

AFFIDAVIT

The undersigned registered scale technician certifies that the above described Portable scale has been inspected and found to be within weight specifications and tolerance specified under the laws, rules and regulations of the State of Iowa.

Signed: ____
(Scale Technician) (Registration Number)

Company: ____

Instructions

1. **Materials producers will forward one signed copy of this report to Chief, Weights and Measures Bureau, Iowa Department of Agriculture, Wallace Building, Des Moines, Iowa 50319.**
2. **One signed copy of this report must be conspicuously posted in the scale house.**
3. **Portable scales, not installed permanently, are not intended to be used at any location for more than 90 days.**

AGGREGATE SAMPLING AT THE PLANT

Current specification calls for the certified technician to run a gradation test on the combined aggregate each day or lot. The sampling techniques taught in the Certified Aggregate School apply to the plant inspector.

Good position, good equipment, and good techniques will result in a good sample.

The standard belt template used in cold feed sampling is quite narrow. If you want to keep your hands clean, you can make a scoop to use with the template. This makes the sampling much easier.

Proper streamflow sampling requires the proper samples, good body position, and three good cuts of the stream.

"A safe and convenient" sampling location should mean that a platform is built so the technician is not handling the sampler in an awkward position.

After running the aggregate gradation test, you should advise the contractor of the results and record them in the plant book. Compare the results to the target gradation and to results from previous tests to see if there are inconsistent results that may mean a problem.

Belt Sampling Technique

Streamflow Sampling Technique

INSTRUCTIONS FOR SAMPLING AND IDENTIFICATION

In order to avoid erroneous conclusions, great care should be taken to select samples that are truly representative.

Make out an identification sheet for each sample submitted. If possible, enclose this sheet in an envelope tag (Form 194) and place inside the shipping container. Tag envelopes tied on the outside of shipments are often lost in transit, causing considerable delay in placing the samples in line for test. If tags must be tied on the outside of packages, mark your sender's number plainly on the package itself and mail a duplicate Form 820193 to the Testing Engineer. Give all information called for by this sheet that applies to the sample being submitted.

"Location of Producing Plant," shall in all cases be indicated by Section, Township, Range and County and location within the Section. Distance and direction from nearest town, and local names of the source in question, may also be indicated in addition to the above information.

"Unit of Material Represented," calls for such information as: Car numbers (where applicable), Station Numbers for tile from line of drain, Station Numbers and distance and direction from center-line, or coordinates for soil samples and samples from undeveloped material deposits. This data must be definite enough to insure that the test report can be accurately connected with the identical unit of material which the sample represents.

"Quantity Represented," calls for the total quantity of material represented by the sample. It is not necessary to indicate the weight of the sample itself.

Asphalt or Road Oil -- Ship in clean tin containers. Do not take samples from top of drum.

Cement -- Eight pounds for regular check samples and fifteen pounds for progress samples. Ship in plastic and canvas bags, obtainable at the warehouse in Ames, or in other tight containers.

Culvert Metal -- One strip of metal 4-1/2 to 5 in. wide cut from the edge or the end of one sheet from each 500 sheets or fraction thereof of each guage, heat and pot number. Heat numbers and Pot numbers, which are stenciled on each sheet, should be included in the identification of the sample.

Gravel, Pit Run -- Sample should consist of 40 lb. of the total material, plus an additional 40 lb. of material retained on the No. 4 screen in a separate container. Ship in clean bags or boxes sufficiently tight to prevent loss of fine material. Never pack samples in sugar sacks. Do not use burlap bags.

Gravel, Screened -- 60 lb. from each car load or other unit of material. Great care must be exercised in selecting samples of coarse material. Select 100 to 200 lbs. and reduce to proper size by quartering. *(See "Manual for Concrete Inspectors.")*

Paint -- One quart from each Lot Number. Stir paint thoroughly before selecting sample. Ship in tight container. Give manufacturer's analysis as printed on the container.

Plastic Pipe--Three five-foot samples. One sample should contain the date and plant code.

Reinforcing Steel -- One test sample from bundles or lots for each heat or 10 tons that can be identified, and two samples from each 10 tons when identification cannot be made. Cut all samples 42" long. Epoxy Coated Bar 60".

Sand -- 35 lb. from each car load or other unit of material. Ship in clean bag or box sufficiently tight to prevent loss of fine material. Never pack samples in sugar sacks. Do not use burlap bags.

Soil -- 25 lb. from each soil type. Show depth of layer for "Quantity Represented."

Stone, Crushed (for Concrete) -- 60 lb. from each carload or other unit of material. Observe instructions for sampling screened gravel.

Stone, Ledge Samples -- Two cement sacks full (about 140 lb.) from each ledge in the quarry face.

Surfacing Material -- For graduation test submit 40 lb. of total material, and for freeze and thaw test and abrasion. submit an additional 40 lb. of pebbles retained on the No. 4 screen in a separate container.

Water -- One quart shipped in a clean glass container.

Wire Mesh -- Submit 24x24 in. Sample from each size of mesh. Note width of sheet and length of overhangs, also indicate the size and grade of pipe in which wire is to be used.

NOTE: -- More complete information with regard to sampling of materials can be secured from District Materials Engineer or Ames Laboratory.

HIGHWAY DIVISION LABORATORY

LOCATION	MATERIALS TESTED
Ames, Iowa	All Materials

During the construction season a number of temporary laboratories at producing plant can test materials before it is shipped. Arrangments for this service can be made through the Central Office at Ames.

Distribution: White copy - Central Materials; Yellow copy - File

Form 820193
7-94

Central Lab. No. ______

Iowa Department of Transportation

IDENTIFICATION OF SAMPLE FOR TEST

(Read Instructions on back before taking sample and filling out form)

Material: Cold Feed Combined Aggregate, 3/4"
Senders Sample No.: CF5-16A

Intended Use: Surface 30M
Contract ID number: 77-0006-41

County: POLK
Group No.:
Design No.: ABD8-1007

Project: NHS-6-3(41)--12-77

Contractor: Quality Asphalt Inc.
(Name) (Address)

Supplier:
Source:

Producer: Quality Asphalt Inc.
Brand:
Lot No.:

Location of Producing Plant: US Highway 6 - Altoona

Sec. ______ Twp. ______ Range ______ Co. ______

Unit of Material Represented:

Quantity Represented: 1/2 split of 40 lb. Field sample

Sampled by: John Rayson (name) Quality Asphalt Inc. (address)

Date sampled: 05/16/98

Report to Tranportation Center(s) (Check appropriate box (es))

DIST. #1	DIST. #2	DIST. #3	DIST. #4	DIST. #5	DIST. #6
X					

Report to Residency (Write appropriate residency number): 11

Report to Counties (Write appropriate count number):

Report to Other: Quality Asphalt Inc.
(Name) (Title) (Address) (Phone)

Report to Other:
(Name) (Title) (Address) (Phone)

Report to Other:
(Title) (Phone)

Results need by: Date ASAP

Additional Detailed Information: (For paint give analysis printed on container. For tile give grade specified, etc.)

" X " Sample Type	
	Verification/Assurance
X	Project Information
	Mix Design
	Dept. Information
	Warehouse Stock
	Research Project

ASPHALT BINDER SAMPLING AT THE PLANT

The second basic material to flow through the plant is the asphalt binder.

The type and grade of binder to be used will be found in the contrast documents (see 2303.02 refer also to plan notes and special provisions). The acceptance for use on the project is the certified delivery ticket.

Sampling of binder is a basic inspection job. References for sampling include Materials I.M. 204 and 323.

Samples should be taken from sampling valves located in the pumping line, between the storage tank and the mixer. Remember that you must waste some material prior to getting the sample so the lines are cleaned of old binder.

This location is accessible, and could be a good sampling setup. A platform to stand on would get the inspectors high enough so the container isn't at eye level. The unsupported container can easily tip over, splashing hot asphalt around. A poor setup is an accident waiting to happen.

A slight difference in the position of the inspector makes a world of difference in the safety and convenience of getting the sample. Remember to use your safety apparel.

Sampling from the transport is not allowed by Specifications. The use of a metal can for binder is not proper, and insulated gloves are a must.

Sometimes changes can be made to make a very awkward location into one that is acceptable. Care must be used to be sure the sample is not contaminated by the fines laying around.

The sample, which will be sent in for test, is placed in tin. The tin is filled by pouring hot binder from the sampling cup. It would be advisable to put a piece of paper under the tin in case of spills.

It is advisable to write the sample number on the can lid before it is filled. The use of insulated gloves is recommended when handling the cardboard container even though it may feel cool enough to handle when you begin.

SAMPLING BITUMINOUS MATERIALS

AASHTO T 40

Developed by

December 11, 1998

NOTE

There are no prerequisites for this training package.

TABLE OF CONTENT

SAMPLING OF BITUMINOUS MATERIALS

This discussion of sampling bituminous materials is limited to the sampling of asphalt cement. Asphalt cement quality is important to producing quality Hot Mix Asphalt (HMA). Using the correct grade of asphalt ensures that the HMA pavement will perform as expected under the conditions encountered in the field. The producers of asphalt cement are responsible for the quality of their product and must operate under a quality control plan. Proper sampling is a key component of any Quality Control/Quality Assurance plan.

As in sampling many products, safety is a major factor. Be sure to always wear the proper safety equipment and use extreme caution around hot asphalt cement.

Sampling locations for asphalt cement include the following:

- from the producers storage facility
- from shipment, or
- from the Hot Mix Asphalt producer's plant

The location of the sample should be as directed by the State Highway Agency.

There are two methods for sampling asphalt cement.

1. By the use of a sample valve attached to the line or tank.
2. Dipping a sampling device into the asphalt from above.

The use of a sample valve is the preferred method.

The asphalt cement samples need to be placed in the proper containers. Always use caution when handling containers filled with hot asphalt cement.

Common Sampling Errors

- Not wasting material before taking a sample from a valve.
- Improper sample container.

TESTING METHODOLOGY

Apparatus

- Safety apparel including - insulated gloves, face shield, long sleeve shirts, long pants, and boots.

- Dipper (when dip sampling)

- Sample containers - these containers need to be clean, tight-sealing metal cans of the proper size. **Do Not use solvents to clean cans.** Use a clean dry cloth to wipe off any material from the outside of the sample cans.

Sampling Procedure - Sampling from a valve (tanks, lines, pipes)

When sampling asphalt cement from a valve, waste at least four liters (one gallon) of the material through the valve before taking the sample. After the material has been wasted, the sample container may be filled.

NOTE

Always check with the owner concerning any special safety issues in the operation of the sampling valves.

Safety is extremely important when sampling asphalt cement.

Sampling Asphalt Cement

Sampling Procedure - Dip Sampling (tanks, tankers, tank cars, barges, distributors)

Asphalt cement in storage may be sampled by lowering a sample device into the material from an access hatch in the top of the tank. The dip sampler is lowered into the material to the proper depth, opened, and allowed to fill. The sampler is then carefully withdrawn and the entire contents of the sampler is then poured into the sample container.

Properly identify all samples by marking the cans (not just the lids) with the type of material, the date, the time, and the sample location, as a minimum.

GLOSSARY

Asphalt cement: Also refered to as "asphalt binder", it is a product normally refined from crude petroleum. There are a few natural asphalt deposits such as Trinidad Lake. It is a black tar like material that is solid at low temperatures and liquid at high temperatures. This allows it to be used as a paving cement by mixing and placing in a liquid state then the natural cooling produces a solid but flexible pavement.

The performance grading (PG) system of classifying asphalt binders is based on the high and low temperatures expected to be found in the pavement during its life. For example: a PG 58-28 is expected to stay stiff at a temperature of 58° C and yet remain flexible at a temperature of -28° C.

Form 820193
7-94

Central
Lab. No. ______

Iowa Department of Transportation

IDENTIFICATION OF SAMPLE FOR TEST

(Read Instructions on back before taking sample and filling out form)

Material: Asphalt Binder PG 58-28 — Senders Sample No.: A5-16A-E

Intended Use: Surface 30M — Contract ID number: 77-0006-41

County: POLK — Group No.: ______ — Design No.: ABD8-1007

Project: NHS-6-3(41)--12-77

Contractor: Quality Asphalt Inc.
(Name) (Address)

Supplier: Bituminous Materials & Supply — Source: Des Moines, Iowa

Producer: Bituminous Materials & Supply — Brand: PG 58-28 — Lot No.: ______

Location of Producing Plant: Des Moines, Iowa

______ Sec. ______ Twp. ______ Range ______ Co. ______

Unit of Material Represented ______

Quantity Represented: Approx. 80 tons each

Sampled by: John Rayson (name) — Quality Asphalt Inc. (address)

Date sampled: 05/16/98

Report to Tranportation Center(s) (Check appropriate box (es))

DIST. #1	DIST. #2	DIST. #3	DIST. #4	DIST. #5	DIST. #6
X					

Report to Residency (Write appropriate residency number): 11

Report to Counties (Write appropriate count number): ______

Report to Other: Quality Asphalt Inc.
(Name) (Title) (Address) (Phone)

Report to Other: ______
(Name) (Title) (Address) (Phone)

Report to Other: ______
(Title) (Phone)

Results need by: Date ASAP

Additional Detailed Information: (For paint give analysis printed on container. For tile give grade specified, etc.)

5 - 3 oz. Tins as per Materials IM 204

"X"	**" X " Sample Type**
	Verification/Assurance
X	Project Information
	Mix Design
	Dept. Information
	Warehouse Stock
	Research Project

HOT MIX SAMPLES

Equipment needed for Sampling

The certified technician may be involved with the hot mix samples. They are normally taken by the road inspector, but at some point, may pass through the plant laboratory. We want you to be familiar with the proper procedures for obtaining and handling the hot mix samples.

The equipment needed for sampling includes the scoop, the putty knife, sample box, and insulated gloves. Remember you are handling asphalt mix that is hotter than boiling water. Make sure you use proper safety precautions. The hot mix sample is a very important sample. It is used to determine the contractor's compliance for density and voids. You must be sure to get a representative sample of the mix being placed. Do not vary from the procedure shown in the I.M. unless necessary, and if you do vary, document why and how.

Section C-3 of I.M. 322 describes the proper location for each increment of the hot mix sample. Make sure that you don't sample the mix too soon. Wait until at least 100 tons (Mg) of mix have been laid out to give the plant time to even out. Also, get four increments from two separate truckloads of material.

The exception to the roadway sample is the sand seal or heater scarification project. The sand seal will leave a scar on the surface if sampled behind the paver. The asphalt mix on a heater scarification job would be contaminated by the scarified material. In these two cases, truck samples must be taken.

The technique of template sampling is not difficult. It does require proper equipment, correct location, and attention to the details of doing the job right. The first hot sample of the day is usually forwarded directly to the District Lab for testing.

For thicker lifts of HMA, such as HMA widening, the regular template will not go deep enough. In this case, you should use the deep template or the jabber sampler. Most of the time, it will work better to use the deep sample template, which is available at each District Materials Office.

Each hot mix sample taken must have an identification form made out. Make sure you fill out the form with all the needed information. Included in this are:

1. The mix type and use
2. The project number
3. The contractor
4. The person who sampled the hot mix
5. Who to report the results to

Be sure to fill out the Form #193 completely.

Hot Mix Roadway Sampling

The laboratory will run the tests on the hot mix sample that is submitted. The process begins with splitting the sample into increments for testing.

Three increments are used to make the density specimens.

The density determination is made by compacting the test specimen using a constant compaction effort. The equipment used is a Marshall Hammer or Gyratory compactor.

The hammer is a constant weight and is dropped a constant distance for an exact number of blows. This will give each sample the same compactive effort. Your mix will either have a 50 blow or 75 blow design, depending on the daily traffic count or special design requirements. The gyratory compactor is programmed to one of seven levels of compaction by setting the number of gyrations based on ESAL's.

The three increments that are ran for Marshall density will result in three specimens, which are weighed and averaged to give the lab density results for the hot mix sample. When using the Superpave Gyratory Compactor, only two specimens are required to average for determining the lab density. Also, if the daily samples for density vary more than 0.03, the backups for the day need to be run and the average used to figure density compliance.

The maximum specific gravity of the sample is determined by the Rice procedure. Together with the density, it is used to determine our lab voids.

We now have two things we need to determine another of the specification controls, the filler bitumen ratio (F/B). This is a ratio of the -200 (-75 μm) material from the cold feed gradation, divided by the percent of binder in the mix, which comes from the tankstick. We now have a minimum F/B spec along with a maximum. For Marshall, the minimum F/B is 0.30 and the maximum is 1.20.

For Gyratory mixes, the effective binder content (G_{se}) is used instead of the total percent binder to calculate the F/B. The Gyratory spec for F/B is a minimum of 0.6 and a maximum of 1.4.

SUBLOT DETERMINATION

If projected production is less than 2000 Tons:

1. First Sublot is ALWAYS 500 Tons
2. One sublot next 750 Tons each

EXAMPLE:

Projected production: 1800 Tons

1. First sublot is ALWAYS 500 Tons
2. Next sublot is 750 Tons
3. Third sublot is 550 Tons

If projected production is 2000 Tons or more:

1. First sublot is ALWAYS 500 Tons
2. Next three sublots = (projected production - 500)/3

EXAMPLE:

Projected production: 4000 Tons

1. First sublot is ALWAYS 500 Tons
2. (4000 - 500)/3 = 1167 Tons for each remaining sublot

SUBLOT DETERMINATION & RANDOM SAMPLE SELECTION

Lot Size Procedure:

First Day Production of a Mix: 4000 tons projected

First Sublot = 500 tons - 100 tons = 400 tons

$$\text{Next 3 Sublots} = \frac{\text{projected output - 500 tons}}{3} = \frac{4000 - 500}{3} = 1167 \text{ tons}$$

Random Ton Determination

Three dice rolls are needed to determine the multiplier for using the random number chart to select a random ton in a lot.

One roll is for the vertical axis and one is for the horizontal axis to define one of the groupings of six random numbers. The third roll is used to select one of the six numbers in the grouping.

The randomly selected multiplier from the chart is multiplied by the mass of the sublot to determine which ton should be sampled.

Example: horizontal = 4
vertical = 3
grouping = 4

From the chart the multiplier = 0.817

Using the sublot size shown above:

Random ton = 0.817 x 1167 = 953 ton

RANDOM NUMBERS TABLE

	1	2	3	4	5	6
1	0.116 0.747 0.876 0.848 0.614 0.234	0.665 0.182 0.290 0.625 0.421 0.886	0.249 0.909 0.247 0.396 0.729 0.390	0.167 0.654 0.041 0.920 0.711 0.498	0.096 0.592 0.010 0.629 0.454 0.586	0.348 0.631 0.131 0.737 0.707 0.863
2	0.558 0.348 0.987 0.461 0.619 0.343	0.721 0.710 0.839 0.141 0.752 0.294	0.690 0.941 0.013 0.441 0.981 0.001	0.287 0.761 0.585 0.396 0.730 0.508	0.219 0.877 0.637 0.715 0.112 0.503	0.716 0.317 0.804 0.395 0.341 0.699
3	0.294 0.842 0.768 0.859 0.710 0.381	0.027 0.952 0.647 0.774 0.279 0.108	0.728 0.092 0.336 0.770 0.522 0.066	0.174 0.495 0.140 0.817 0.764 0.068	0.301 0.393 0.528 0.191 0.246 0.086	0.355 0.970 0.070 0.934 0.695 0.941
4	0.217 0.563 0.440 0.037 0.130 0.912	0.138 0.684 0.836 0.713 0.845 0.132	0.122 0.368 0.834 0.879 0.906 0.469	0.435 0.975 0.116 0.223 0.654 0.255	0.638 0.894 0.678 0.768 0.233 0.584	0.348 0.399 0.260 0.281 0.646 0.209
5	0.201 0.162 0.628 0.366 0.259 0.988	0.475 0.037 0.514 0.554 0.895 0.670	0.738 0.509 0.586 0.506 0.840 0.625	0.337 0.415 0.237 0.098 0.070 0.781	0.031 0.451 0.578 0.054 0.350 0.772	0.888 0.894 0.915 0.932 0.930 0.241
6	0.368 0.664 0.034 0.189 0.669 0.163	0.067 0.781 0.924 0.992 0.462 0.410	0.562 0.423 0.242 0.373 0.986 0.004	0.625 0.090 0.998 0.279 0.166 0.770	0.831 0.790 0.241 0.643 0.017 0.902	0.857 0.628 0.173 0.283 0.998 0.188

SAMPLING BITUMINOUS PAVING MIXTURES

AASHTO T 168

Multi-Regional Training and Certification

M-TRAC

FHWA SPONSORED

Developed by

December 11, 1998

TABLE OF CONTENT

Sampling Bituminous Paving Mixtures

This discussion concerns obtaining samples of bituminous paving mixtures for laboratory testing. Proper sampling is a key component of any Quality Control/Quality Assurance plan. Hot mix asphalt(HMA) is best sampled at the last point, in the construction process, where loose mixture is available. This is normally behind the laydown machine before the rollers begin compacting the mixture. Samples of HMA are normally analyzed for their "volumetric" properties, such as the percent air voids by volume. Some agencies also require HMA to be tested for asphalt content and aggregate gradation. When sampling HMA, it is important to obtain enough material to perform all the required tests plus extra material for retesting when test results are questionable.

There are two methods for sampling bituminous paving mixtures. The mixture may be sampled from the roadway or out of a truck. Truck sampling is used only when roadway sampling is not practical.

Safety is very important when sampling hot mix asphalt due to the temperature of the mixture. Always wear protective garments and shoes to keep the hot mix asphalt from coming in contact with the skin. As with any construction project, being alert to traffic is important.

Common Sampling Errors

- Obtaining the entire sample from a single location.
- Not removing all the material from within a template.
- Contaminating the sample with underlying material
- Segregating the material while sampling.

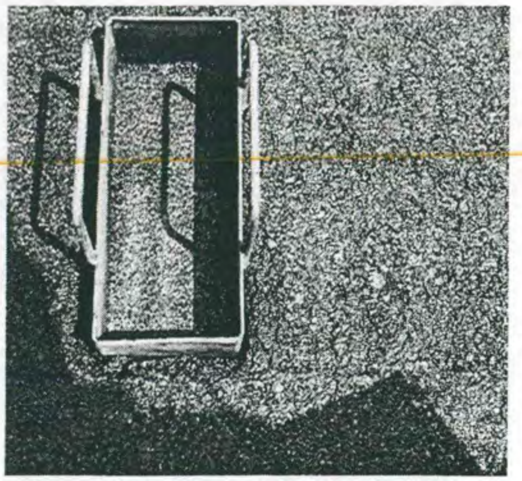
SAMPLING METHODOLOGY

Apparatus

- Square ended shovel or scoop
- Template (roadway sampling)
- Clean sample container
- Protective clothing, insulated gloves, safety shoes

Roadway Sampling

Random sampling locations should be determined. Sample the uncompacted mat by placing a template through the entire lift of HMA, or using a square pointed shovel to create a sample area with vertical faces. Remove all material from within the template or between the vertical faces and place in a clean sample container. Avoid contaminating the sample with any underlying material. At least three increments should be obtained for each sample.



Template Placed in Asphalt Mat

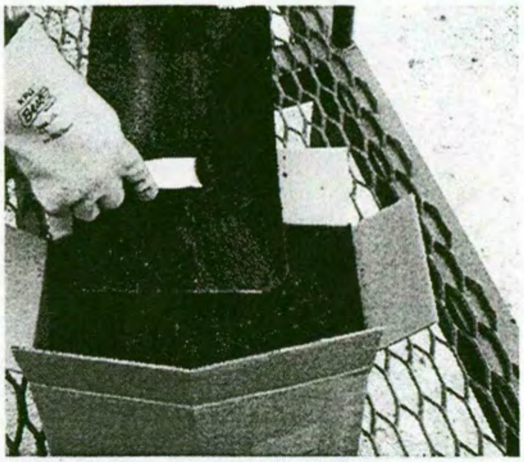
Cleaning Asphalt Off Template Into Sample

Truck Sampling

When roadway sampling is not practical, then truck sampling should be used.

Sample from the truck load by first removing approximately one foot of material from the outside of the mass. Using a square shovel or scoop, remove enough material from the sample area to provide approximately ⅓ of the sample size. Care must be taken to avoid segregating the material while sampling. Place each increment in the clean sample container. At least three increments should be obtained for each sample. Increments from more than one truck load should be included in the sample.

Sampling From A Truck



Scraping Sample off Shovel Into sample Box

Sample Identification

Properly identify each sample by marking the sample container with a project identifier, the type of material, date, time, and the sample location. This is the minimum information that should be included with each sample.

GLOSSARY

Hot Mix Asphalt - a mixture of aggregate and asphalt cement, sometimes including modifiers, that is produced by mixing hot dried aggregate with heated asphalt in a plant designed for the process.

Template - a device used to create a sample area, often no more than a steel box without a top. If the template is inserted after the material is spread, it does not have a bottom. Templates have the advantage of avoiding any segregation during sampling.

EXAMPLE QMA HOT MIX SAMPLE IDENTIFICATION SYSTEM

LETTER #

1. Two letters designating the intended use of the mix.

   BA = BASE   IN = INTERMEDIATE   SU = SURFACE

2. The Date Using a month/date format

   May 16 = 5-16

3. A letter designating position of the box sample during the production day.

   "A" for first box,   "B" for second box, etc.

Example: Second Box of Day, Surface Mix, on October 10.

Sample ID = SU10-10B

Also: Include Mix Type, Contractor Name, Entire Project No., and intended % Binder on the side of the box along with senders ID. This prevents confusion at the District Lab and provides clear positive identification of the sample.

Form 820193
7-94

Central
Lab. No. ____________

Iowa Department of Transportation

IDENTIFICATION OF SAMPLE FOR TEST

(Read Instructions on back before taking sample and filling out form)

Material: HMA 30M ESAL 3/4" @ 5.4% Asphalt Binder
Senders Sample No.: SU5-16A

Intended Use: Surface 30M
Contract ID number: 77-0006-41

County: POLK
Group No.:
Design No.: ABD8-1007

Project: NHS-6-3(41)--12-77

Contractor: Quality Asphalt Inc. (Name) (Address)

Supplier:
Source:

Producer: Quality Asphalt Inc.
Brand:
Lot No.:

Location of Producing Plant: US Highway 6 - Altoona

Sec. ____ Twp. ____ Range ____ Co. ____

Unit of Material Represented:

Quantity Represented: Approx. 500 tons

Sampled by: John Rayson (name) Quality Asphalt Inc. (address)

Date sampled: 05/16/98

Report to Tranportation Center(s) (Check appropriate box (es))

DIST. #1	DIST. #2	DIST. #3	DIST. #4	DIST. #5	DIST. #6
X					

Report to Residency (Write appropriate residency number): 11

Report to Counties (Write appropriate count number):

Report to Other: Quality Asphalt Inc. (Name) (Title) (Address) (Phone)

Report to Other: (Name) (Title) (Address) (Phone)

Report to Other: (Title) (Phone)

Results need by: Date ASAP

Additional Detailed Information: (For paint give analysis printed on container. For tile give grade specified, etc.)

60 lb. Mix sample as per IM 204

	" X " Sample Type
	Verification/Assurance
X	Project Information
	Mix Design
	Dept. Information
	Warehouse Stock
	Research Project

HMA PAVEMENT CORES

The certified technician will be involved in the roadway density, thickness, and voids determination. These are found by testing cores cut from the completed pavement. Your job can be any of several functions, including locating, witnessing, and testing cores. The grade inspector may be asked to locate and witness the core cutting. Core locations must be selected at random to represent the pavement selections. Casting a die or using a random number table are the most commonly used methods of random location. The location of the core is marked out on the pavement. After drilling the core, it is removed from the location. Pavement cores are another instance where the answers are only as good as the sample. Three areas of compliance are determined by these cores. The contractor and inspector must both use care in processing them. If you see an obvious problem, take care of it before a wrong answer makes the problem bigger. When you are coring, decide when to check for a damaged core after it is removed. Check for thickness. The core being tested must represent the pavement layer as placed. If extra material cannot be readily removed, it may be necessary for the contractor to trim the core to get an accurate test sample. When two layers are together, check for thickness before trimming.

CORES AND DENSITY GUIDE INFORMATION

1. Cores and Density (items covered)
   - A. Location
   - B. Cutting and Transportation
   - C. Damaged Cores (inspect each BEFORE testing)
   - D. Field book set up and computer worksheet
   - E. Weighing procedures Article 2001
   - F. Calculations, Density, and Air Voids
   - G. Quality Index, Density, and Thickness
   - H. Correlation with the District labs.

2. Location
   - A. Reference
     1. Construction manual, Chapter 8,13
     2. I.M. 204 frequency
     3. I.M. 337 thickness
     4. I.M. 321 density and voids
     5. Article 2303
     6. Current Supplemental Specifications
     7. I.M. 508 ACC Plant Manual
   - B. Specifications designate the number of cores for a lot when payment is based on:
     1. Tonnage, Sq. Yd., and Thickness (7 density samples will be taken for each lot).
     2. Thickness <u>cannot</u> be less than 70% and no more than 150% of intended thickness.
     3. Test strips for mixes which have a plan quantity over 1500 ton (1500 Mg) may be required. Check Requirements.

        NOTE: 1 extra core is needed when doing a test strip. The lowest density core is thrown out.
   - C. Definition of a "LOT"
     1. One layer of one mixture placed during one day's operation
     2. If brought up at preconstruction conference, contractor may divide days run into 2 lots
     3. Exception 1" or less, each ½ day's construction will be a lot.

D. Random Sampling

1. Roll a die
2. Random Numbers

3. Cutting, Care, and Transportation of Density Cores

A. Specifications require the cores to be cut as promptly as practical. The grade inspector will mark and lay cores out. Grade Inspector or Monitor can witness the cutting of cores.

1. Monitor witness the cutting of cores
2. Monitor transport the cores to the lab
3. Contractor tests the cores (except on non-QMA jobs)
4. Contractor records results in plant book & daily Form 800241 (except on non-QMA jobs)
5. Monitor will box them up and fill out the 193 (contact your District Lab to see how they want them sent in).

B. Cores should be sampled no later than the following work day. The contractor is given a 16" circle to cut in, only because he cannot stop in exactly one spot. Most of the coring machines are built on two wheel trailers. NO NUCLEAR MACHINE is to be used to find the best place to core!!!!!!

C. If the contractor cannot meet these guidelines, he should be shut down. First consult with Tech 3, Assistant RCE, or RCE before taking any action against contractor.

D. Keep core bits sharp.

E. **DO NOT** pry on the cores with a screw driver, use a set of tongs. If they cannot be removed with a hard knock, then drill full depth and remove the underlying layers with a masonry saw.

F. Transportation: Cores should be transported on a hard, flat surface, not in the back of a pickup, not in a pail of water, not in a cardboard box. Cores should **NEVER** be kept in the freezer. Cores should never be placed on their sides, they should be laid flat. If it is a long trip to the lab, cores should be put in plastic bags and placed in a cooler with some ice. This is to prevent the cores from getting too hot and falling apart.

4. Damaged Cores

   A. Typical Damage to Cores

      1. Cracks
      2. A piece might fall off

   B. EACH INDIVIDUAL CORE HAS TO BE INSPECTED PRIOR TO RUNNING.

   Be sure to remover the tack coat. Do not saw if not necessary. Sawing seals the surface of the core approximately 60%.

      1. If the core has obvious damage, there is one more thing you need to check, check the thickness. Cores must be at least 70%, but not more than 150% of intended thickness.

   C. Density Cores

      1. Be absolutely positive that the cores you are running represent the finished product.

   D. Masonry Saw

      1. If cores have part of the old road or has the intermediate lift still attached, this should be sawed off.
      2. The contractor on the road or at the plant site will do the sawing of the cores.

5. Density:

The state of being dense, the quantity per unit volume or the mass of a substance per unit volume 2.350 x 1000 = 2350 kg/m³ (2.350 x 62.4 = 146.64 lb./ cu. ft.). Design quantity is based on kg/m³ (#/cu. ft.). It is usually 2350 kg (145 #).

Specific Gravity:

The ratio of the density of a substance to the density of a substance such as water.

Compaction:

The state of being compacted. The art or process of compacting.

Density is nothing more than a determination of how much compactive effort the contractor has taken when rolling an HMA mixture. The specifications require a minimum amount of density in relation to lab density. The lab density comes from the average of the QC tests run by the contractor each day and has been determined to be 100% of density of that particular mix.

1. Class 1A compaction is 96% of density and 8.0% voids max.
2. Class 1B compaction is 95% of density and 8.0% voids max.
3. Class 1C compaction is 94% of density and 8.0% voids max.

6. Things to check before testing cores:
    A. Set scales on a tall stand
    B. Hang the basket from the bottom of the scale, not from the beam of the scale
    C. Fill the bucket to approximately ¾ full with water
    D. Check that the scale balances to zero
    E. Maintain the water level above the basket. (If it falls below, it will change the scale balance and your final answer.)
    F. Check that the basket does not touch the side or the bottom of the bucket

Form 820193
7-94

Central Lab. No. ______

Iowa Department of Transportation

IDENTIFICATION OF SAMPLE FOR TEST

(Read Instructions on back before taking sample and filling out form)

Material: Field Cores
Senders Sample No.: FC5-16

Intended Use: Surface 30M
Contract ID number: 77-0006-41

County: POLK
Group No.: ______
Design No.: ABD8-1007

Project: NHS-6-3(41)--12-77

Contractor: Quality Asphalt Inc.
(Name) (Address)

Supplier: ______
Source: ______

Producer: Quality Asphalt Inc.
Brand: ______
Lot No.: ______

Location of Producing Plant: US Highway 6 - Altoona

______ Sec. ______ Twp. ______ Range ______ Co. ______

Unit of Material Represented: ______

Quantity Represented: 3805.24 tons

Sampled by: John Rayson (name) Quality Asphalt Inc. (address)

Date sampled: 05/17/98

Report to Tranportation Center(s) (Check appropriate box (es))

DIST. #1	DIST. #2	DIST. #3	DIST. #4	DIST. #5	DIST. #6
X					

Report to Residency (Write appropriate residency number): 11

Report to Counties (Write appropriate count number): ______

Report to Other: Quality Asphalt Inc.
(Name) (Title) (Address) (Phone)

Report to Other: ______
(Name) (Title) (Address) (Phone)

Report to Other: ______
(Title) (Phone)

Results need by: Date ASAP

Additional Detailed Information: (For paint give analysis printed on container. For tile give grade specified, etc.)

7 Cores for correlation from mat laid 5-16-98

"X"	**Sample Type**
	Verification/Assurance
X	Project Information
	Mix Design
	Dept. Information
	Warehouse Stock
	Research Project

TESTING

TANK STICKING

There are some specifications and guidelines you must be familiar with as well as knowing the proper material to use, which is specified on the plans, and temperature at which to supply it to the mix. (Ref. 2303.03B1b). These are beginning-of-the-job items that also require monitoring periodically. The last item, binder quantity, is a major responsibility of the certified technician, and will be discussed in detail.

The storage facility includes the tank, an access port so that measurements can be taken, a safe and convenient way to get to the access port, and a measuring stick to determine the quantity of binder in the tank. The access ports are located on top of the tank. (You will be working with a contractor's representative when doing this work so let them open the port. If there is more than one port on the tank, be <u>sure</u> you check which one is to be used for measurements.)

Safety First

We again emphasize your SAFETY. The top of tanks, especially round ones, is not the safest place to be. It can be windy, wet, and dirty. You <u>must</u> have a safe way to get to the port and a safe place to work when making the measurements. The contractor should not begin operations until this is provided.

DO NOT begin operations until the access port area is safe!

Measurements of the level of binder are made by using a measuring "stick" which has been calibrated for use with a particular tank. The stick will be marked with the gallons (liters) in the tank, the gallons (liters) used from the tank, the diameter of the tank measured in inches (millimeters) or the percent of the tank that is filled.

The direct reading stick has irregular spacings if the tank is round. The percentage reading stick will have uniform gradations.

The Stick should be labeled with:

- **Tank Number**
- **Tank Capacity**
- **Percent of capacity not filled with binder**

Each measuring stick should have the tank number on it. Some may have the tank capacity also. You must know the proper stick is being used to measure the binder quantity. The stick should have the tank number, the tank capacity, and the percent of capacity not filled with binder.

The measurement is taken from the top of the tank to the level of the binder. The measurement should be recorded immediately after being read, and may be observed by the plant monitor.

Most tank sticks will need to be converted into a quantity. From a stick that shows inches (millimeters) of binder remaining, you can establish a chart that converts the measurements to gallons (liters). It may be necessary for the inspector to use the tables in I.M. T-104 to obtain the quantity of binder in the tank.

The tankstick measurement is used to determine how much binder was used during the time period checked.

The information gathered must be entered in the appropriate field book and reporting program.

There are three reasons to determine the binder quantity. First, to determine the percentage of binder in the mix. Second, to see that the percent is on target and within the tolerance. Third, to determine the quantity that will be paid for as part of the contract.

The percent of binder we want the contractor to put into the mix is determined by the mix design (already discussed). The tolerance for percentage of binder is found in 2303.04B2. The determination of quantities for pay are described in 2303.05B.

The binder determination worksheet is a basic tool for the certified technician. If the technician is not using the computerized plant report program, the binder determination worksheet may be used. The complete instructions on how to fill out the form are in I.M. 509.

DAILY VIRGIN ASPHALT BINDER TANK MEASUREMENT SHEET

Project No.: NHS-6-3(41)--12-77 Date: 6/18/1998

Contract ID.: 77-0006-41 Report No.: 1

Start Of Period

Tank No.:	1			
Time:	6:00 AM			
Tank Capacity (Gallons) (A):	20,000			
Outage (% of Diameter) (B):	89.2			
T-104 Innage (% of Capacity) (C):	5.8258			
Direct Reading (Gallons) (D):				
Temp. °F (E):	284			
T-102 Temp. Corr. Factor (F):	0.924			
Corrected Gallons (G)= (A*C*F)or(D*F):	1,077	0	0	0
Total Corrected Gallons (H)= (G+G+G+G):	**1,077**			

Total Asphalt Binder Added

Total Pounds (I):	487,954			
Weight Per Gallon (J):	8.5300			
Total Corrected Gallons (K)= (I+I+I+I/J):	57,204			

End Of Period

Time:	7:30 PM			
Tank Capacity (Gallons) (L):	20,000			
Outage (% of Diameter) (M):	62.4			
T-104 Innage (% of Capacity) (N):	34.3770			
Direct Reading (Gallons) (O):				
Temp. °F (P):	293			
T-102 Temp. Corr. Factor (Q):	0.9210			
Corrected Gallons (R)= (L*N*Q)or(O*Q):	6,332	0	0	0
Total Corrected Gallons (S)= (R+R+R+R):	6,332			

Calculations

Total Corrected Gallons Used (T)= (H+K-S):	51,949
Average Weight Per Gallon (U):	8.5300
Total Pounds Of Binder Used (V)= (T*U):	443,125
Total Pounds Of Mix Made (W):	8,391,190
Total Pounds Of Mix Wasted (X):	2,205
Total Pounds Of Binder Wasted (Y)= (X*Z):	116
Net Tons Of Binder Used On Road = ((V-Y) / 2000):	**221.50**
Net Tons Of Mix Used On Road = ((W-X) / 2000):	**4,194.49**
Percent Virgin Binder by Tank Stick (Z)= ((V / W) * 100):	**5.28**

Comments:

DAILY VIRGIN ASPHALT BINDER TANK MEASUREMENT SHEET

Project No.: NHS-6-3(41)--12-77

Date: 6/18/1998

Contract ID.: 77-0006-41

Report No.: 1

Start Of Period

Tank No.:	1			
Time:	6:00 AM			
Tank Capacity (Liters) (A):	75,708			
Outage (% of Diameter) (B):	89.2			
T-104 Innage (% of Capacity) (C):	5.8258			
Direct Reading (Liters) (D):				
Temp. °C (E):	140			
T-102 Temp. Corr. Factor (F):	0.9236			
Corrected Liters (G)= (A*C*F)or(D*F):	4,074	0	0	0
Total Corrected Liters (H)= (G+G+G+G):	4074			

Total Asphalt Binder Added

Total Kilograms (I):	221,336			
Mass Per Liter (J):	1.0240			
Total Corrected Liters (K)= (I+I+I+I/J):	216,148			

End Of Period

Time:	7:30 PM			
Tank Capacity (Liters) (L):	75,708			
Outage (% of Diameter) (M):	62.4			
T-104 Innage (% of Capacity) (N):	34.3770			
Direct Reading (Liters) (O):				
Temp. °C (P):	145			
T-102 Temp. Corr. Factor (Q):	0.9207			
Corrected Liters (R)= (L*N*Q)or(O*Q):	23,962	0	0	0
Total Corrected Liters (S)= (R+R+R+R):	23,962			

Calculations

Total Corrected Liters Used (T)= (H+K-S):	196,260
Mass Per Liter (U):	1.0240
Total Kilograms Of Binder Used (V)= (T*U):	200,970
Total Kilograms Of Mix Made (W):	3,806,244
Total Kilograms Of Mix Wasted (X):	1,000
Total Kilograms Of Binder Wasted (Y)= (X*Z):	53
Net Mg. Of Binder Used On Road = ((V-Y) / 1000):	**200.92**
Net Mg. Of Mix Used On Road = ((W-X) / 1000):	**3,805.24**
Percent Virgin Binder by Tank Stick (Z)= ((V / W) * 100):	**5.28**

Comments:

Lab. No.:	grad 1-A
Orig. Dry Mass:	2,555.0
Dry Mass Washed:	2,451.0
Total Minus #4 (W1):	
Reduced Minus #4 (W2):	
Conversion Factor:	

Only use green colored cells when (Using Box & 8 in. Sieves).

Sieve Size	Reduced Minus #4	Total or Calc Mass Retd.	% Retd.	% Passing	Reported Final	Composite % Psg.	Reported Final	Specs.
1 1/2 in.				100.0	100			
1 in.				100.0	100			100
3/4 in.		15.4	0.6	99.4	99			90-100
1/2 in.		275.6	10.8	88.6	89			83-90
3/8 in.		325.5	12.7	75.9	76			76-90
#4		740.0	29.0	46.9	47			43-57
#8		456.0	17.8	29.1	29			23-35
#16		255.4	10.0	19.1	19			
#30		163.3	6.4	12.7	13			7-15
#50		130.5	5.1	7.6	7.6			
#100		55.7	2.2	5.4	5.4			
#200		30.5	1.2	4.2	4.2			2.0-5.3
Pan		3.3	4.2					
Wash		104.0						
Totals		2,555.2	100.0					
Tolerances		100.0						

Plant Moistures (Pan Dry)

Project No.: NHS-6-3(41)--12-77 Contract ID.: 77-0006-41

Date	Material Type	Wet Wt. (Grams)	Dry Wt. (Grams)	Difference (Grams)	Moisture (%)	Remarks	By
05/16/98	Surface 30M	2,105.5	2,017.1	88.4	**4.38%**		jr
05/16/98	Surface 30M	2,456.3	2,354.4	101.9	**4.33%**		jr
05/17/98	Surface 30M	2,216.2	2,131.1	85.1	**3.99%**		jr
05/17/98	Surface 30M	2,612.8	2,515.6	97.2	**3.86%**		jr

UNCOMPACTED VOID CONTENT OF FINE AGGREGATE

AASHTO T 304

FHWA SPONSORED

Developed by
FHWA Multi-Regional Aggregates Training & Certification Group

July 1999

NOTE

Successful completion of the following training materials, including examination and performance evaluation are prerequisites for this training package.

- AASHTO T84, Specific Gravity of Fine Aggregates
- AASHTO T11, Materials Finer than 75µm (No. 200) Sieve by Washing.

Table of Contents

AASHTO T304, Uncompacted Void Content of Fine Aggregate

Scope

This method determines the loose uncompacted void content of a sample of fine aggregate. When performed on an aggregate sample of a known, standard grading (Method A), this measurement provides an indication of particle shape. The materials' angularity, roundness or surface texture relative to other materials of the same standard grading is indicated by the percent of voids determined by this test. The Superpave asphalt mix design method sets minimum requirements for void content that vary depending on traffic loads and depth from the surface of the asphaltic concrete pavement. In this method, the prepared sample is allowed to free-fall through a standard funnel of a specified diameter, from a specified height into a small cylinder of known volume (nominal 100 ml).

When performed on an "as received" sample (Method C), this method can serve as an indicator of the effect the fine aggregate can have on the workability of Portland Cement concrete.

> NOTE: This manual covers Test method A only.

The material is then leveled with the top of the calibrated cylinder and weighed. Because the volume and weight of the cylinder are known, the weight of the sample contained in the cylinder can be calculated. Using the Bulk Dry Specific Gravity (As determined by AASHTO T84), the volume of the material in the cylinder is calculated. By subtracting the calculated volume of material from the calibrated volume of the testing cylinder, the volume of voids can be calculated.

Summary of Test Method

A sample of sand is prepared in accordance with one of three methods. Method A, a standard gradation, is the most common used. The sample is allowed to free-fall from a funnel into a cylinder of known volume. Using the bulk dry specific gravity of the sample as determined by AASHTO T84, the percent of void space in the cylinder is calculated. This value is known as the Fine Aggregate Angularity Value or FAA.

Typical Test Results

Using Method A, values typically range between 35 to 43 for natural sands and from 43 to 50 for crushed products. Values are obtained from more than one test of the same sample.

Common Testing Errors

1. Improper calibration of test cylinder or damage to test cylinder resulting in a change in volume.
2. Vibration in test area resulting in over-compaction of sample in test cylinder.
3. Erroneous specific gravity used in calculation. A difference of 0.05 specific gravity can cause an error of 1.0-% FAA value.

Apparatus

- Cylindrical measure approximately 39 mm (1.56 in.) in diameter, 86 mm (3.44 in.) deep with a capacity of approximately 100-mL.
- Funnel conforming to figure 2 in AASHTO T304.
- Funnel Stand conforming to figure 2 in AASHTO T304.
- Glass Plate for calibrating cylindrical measure.
- Pan large enough to contain funnel stand and to catch overflow material.
- Metal spatula with a straight edge approximately 100 mm (4.0 in.) long and 20 mm (0.8 in.) wide.
- Balance accurate and readable to 0.1 grams.

Procedure – Only Method A will be covered in this procedure, for other methods consult AASHTO T304

1. Wash representative sample in accordance with T11. The size of this sample is dependent on the gradation of the sample. Generally 500 grams to 700 grams is sufficient to yield the necessary size fraction quantities.

2. Dry washed sample material in a 110+/- 5 ° C (230+/- 9 °F) oven to a constant weight.

Sieve material in accordance with AASHTO T27. Remove the following size fractions from the sieves and retain in separate, labeled containers:

Passing No. 8 – Retained on No. 16
Passing No. 16 – Retained on No. 30
Passing No. 30 – Retained on No. 50
Passing No. 50 – Retained on No. 100

3. Weigh individual size fractions and combine them in accordance with the following:

Size Fraction	Mass, grams
No. 8 X No. 16	44
No. 16 X No.30	57
No. 30 X No.50	72
No. 50 X No.100	17
Total	**190**

4. Mix combined sample thoroughly with spatula.

5. Place finger under opening in funnel to seal opening. Pour mixed sample into funnel.

Pouring sample into funnel

6. Quickly remove finger from funnel and allow sample to free-fall into the calibrated cylinder.

7. Take care not to vibrate or unnecessarily disturb the material in the cylinder to avoid further consolidation. Strike off the excess material above the lip of the cylinder with the spatula edge, held in a vertical position, using one continuous motion.

8. After striking off, remove any excess sand from the outside of the cylinder using a small brush. At this point, additional compaction of the material in the cylinder will not affect the test results and will aid in handling.

9. Weigh the cylinder with the sample and record to the nearest 0.1 grams. Retain and recombine all materials for the next trial.

Weighing the Cylinder

Calculate uncompacted voids content as follows:

$$U = \frac{V - (F / G)}{V} x100$$

Where:

V = Volume of calibrated cylinder in mL (cubic centimeters)
F = Net Mass of Sample in Cylinder (Gross mass minus mass of empty cylinder)
G = Bulk dry specific gravity as determined by AASHTO T84
U = Uncompacted Voids in Percent (reported to nearest 0.1%)

10. Repeat test using recombined sample. Calculate and report average of at least two trials.

Instructors Note: Experience has shown that variability in results decreases with operator experience and an increase in the number of trials performed. It is recommended that at least three trials be performed and that three consecutive results be checked against the single operator precision statement in AASHTO T304.

Example Calculations:

Natural Sand

Volume of Cylinder: 99.92 mL
F= 156.36gm.
G= 2.643

$$U = \frac{99.92 - (156.36gm. / 2.643}{99.92} \times 100 = 40.8$$

Manufactured Sand

Volume of Cylinder: 99.92 mL
F= 143.15
G= 2.862

$$U = \frac{99.92 -(143.15 / 2.862)}{99.92} \times 100 = 49.9$$

Quiz

1). Uncompacted voids is an indicator of.....
   a). The aggregates' surface texture.
   b). The roundness of the aggregate.
   c). The angularity of the aggregate.
   d). All of the above.

2). An error in specific gravity of 0.05 can effect the calculated voids result by as much as:
   a). 5.0%
   b). 1.0%
   c). 2.5%
   d). 10.0%

3). Vibration in the testing area will not effect the test results.
   True False

4). To calculate uncompacted voids the SSD specific gravity as determined in AASHTO T84 is used.
   True False

5). The calibrated volume of the Cylinder is not critical to the calculation.
   True False

GLOSSARY

Voids- Difference between the total volume and the volume occupied only by the aggregate particles. The amount of void space (or air space) is a function of the aggregate gradation, particle shape and texture, and the amount of compaction of the material.

Uncompacted Voids- The amount of void space present when the material is in an uncompacted, unconsolidated state.

Bulk Dry Specific Gravity- The ratio of the mass in air of a unit volume of aggregate at a stated temperature to the mass in air of an equal volume of gas-free distilled water at the stated temperature.

Angularity- a description of the degree of roughness, surface irregularities or sharp angles of the aggregate particles (i.e. particle shape).

PLASTIC FINES IN GRADED AGGREGATE AND SOILS BY USE OF THE SAND EQUIVALENT TEST

AASHTO T176

Developed by
FHWA Multi-regional Training & Certification Group

July 1999

Note:
Successful completion of the following training materials, including examination and performance evaluations are prerequisites for this training package.

- AASHTO T 176, Standard method of Testing for Plastic Fines in Graded Aggregate and Soils By Use of Sand Equivalent Test.

Reference AASHTO Tests

- AASHTO T 2, Standard Practice for Sampling Aggregate
- AASHTO T 27, Sieve Analysis of Fine and Coarse Aggregate
- AASHTO T 248, Reducing Samples of Aggregate to Testing Size

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Plastic Fines in Graded Aggregate and Soils by Use of the Sand Equivalent Test

Scope

The Sand Equivalent Test uses a liquid solution to separate the clay-like material (fine dust) from the larger material in a sample that passes the No. 4 sieve. Once the clay-like material is separated the percent or amount of material in a sample that has similar characteristics to sand can be determined. A higher sand equivalent value indicates that there is less clay-like material in a sample. Clay-like materials have a direct effect on the performance of Hot Mix Asphalt (HMA) and the amount should be controlled to provide quality bituminous mixtures. A large amount of clay-like particles can coat the aggregate surfaces and prevent the liquid asphalt from completely coating and adhering to the aggregate.

Apparatus

The following equipment is needed to perform the sand equivalent test. The equipment needs to conform to the specifications and dimensions of the standard test method. Additional accessory items are also noted in a list of materials in the stan dard test method.

- A plastic graduated cylinder with a rubber stopper.
- Irrigation Tube
- Weighted foot assembly
- Siphon assembly
- Tinned Measure
- Wide-Mouth Funnel
- A clock or watch
- A mechanical or manual shaker
- Bottle of solution

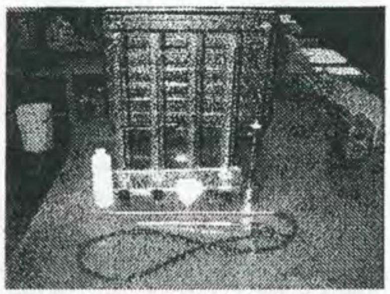


Figure 1 - Graduated Cylinder, Irrigation Tube, weighted foot Assembly and Siphon.

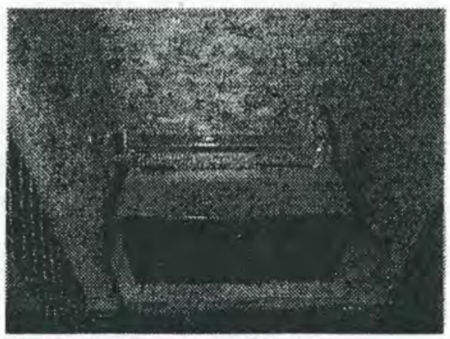


Figure 2 - Mechanical Shaker

Note:
The solution is placed on a shelf 915 mm±25 mm (36 in.±1 in.) Above the work surface.

Summary of Test

The sand equivalent value of a prepared sample is determined by placing the sample into a graduated cylinder with the test solution. After the sample has soaked, the cylinder is capped off or sealed. The cylinder is then shaken in a horizontal position to completely mix the sample and solution.

There are three separate methods that can be used to shake a sample. The preferred or recommended method is the method using a mechanical shaker. The other two, the manual shaker or the hand method can be used, but each one has specific requirements that must be maintained to obtain accurate results.

When the mixing is finished the cylinder is stood upright, irrigated and allowed to stand undisturbed. The sample will sink toward the base of the cylinder. The heavier particles will sink to the bottom of the cylinder rapidly and the suspended fine material will slowly settle toward the bottom. After 20 minutes ± 15 sec. the top of the suspended material is noted as the clay reading. The sand reading is noted after a weighted assembly is lowered into the cylinder and it comes to rest on the surface of the sand or coarse material that has settled out. Once the readings are obtained a simple calculation is used to determine the sand equivalent value.

Test Precautions

This test method has numerous steps where errors can be introduced, unless certain details are carefully controlled or monitored before and during the test procedure. The prepared solution of calcium chloride, glycerin and formaldehyde solution should be mixed, used and maintained with care. The Material Safety Data Sheets should be used for any safety issues associated with this test when using the noted solution.

Most of the precautions are associated with good laboratory techniques and watching the details. The sample preparation and the shaking of the sample have specific requirements that are needed for accurate test procedures, and test results.

Sample Preparation

The test is conducted on soils or graded aggregate passing the 4.75mm (No. 4) sieve. When separating the sample special care should be made to collect all the minus 4.75mm (No. 4) material. Any clumps or dust should be broken apart and included with the material passing the 4.75mm (No. 4) sieve.

Split the sample into the desired number of test samples, with enough material to slightly overfill the tin measure. Set up each test sample by either one of the alternate methods described in the standard specification, or the referee method (mechanical shaker).

Test Procedure

The following step by step procedure for the mechanical shaker (Referee Method) is recommended to understand the laboratory techniques needed for accurate test results.

1. Allow the initial sample to air dry.

2. Split or quarter the sample until you have slightly more material than it will take to fill a 3 ounce tin cup. The tin cup is in the case marked SAND EQUIVALENT.

3. Place the tin cup in a larger flat container. A bread pan will work.

4. Take the sample obtained by splitting or quartering and slowly pour the sample into the tin cup.

5. As you pour the sample, gently tap the bottom edge of the tin cup on a hard surface (the bottom of the large flat container will work.)

6. After filling, strike off the top of the tin cup with a straight edge.

7. Remove one of the plastic graduated cylinders from the case marked "SAND EQUIVALENT".

8. Place the cylinder on the sink by the siphon assembly.

9. Siphon 4.0+/-0.01 inches of working calcium chloride solution into the cylinder.

10. Pour the content of the tin cup into the solution.

11. Tap the bottom of the cylinder several times with the heel of your hand to help release trapped air bubbles and promote thorough wetting of the sample.

12. Let the cylinder and sample stand undisturbed for 10 +/-1 minutes.

13. Place the rubber stopper in the cylinder.

14. Loosen the material from the bottom of the cylinder.

15. Place the cylinder in the Mechanical Shaker.

16. Tighten the screw to hold the cylinder.

17. Turn the Mechanical Shaker on.

18. BE SURE TO HOLD THE MECHANICAL SHAKER IN PLACE, IF IT HAS NOT BEEN

ANCHORED TO A FIRM FLAT SURFACE.

19. When the shaker is finished, loosen the screw.

20. Remove the cylinder.

21. Remove the stopper.

22. Place the cylinder on the sink by the siphon assembly.

23. Remove the irrigation tube from the glass.

24. Place the irrigation tube into the cylinder.

25. Loosen the restraints on the siphon tube.

26. Rinse the material from the cylinder walls as you lower the tube into the cylinder.

27. Force the irrigation tube through the sample.

28. Twist the irrigation tube.

29. Keep forcing and twisting the tube through the sample.

30. Keep doing this until the fluid level reaches approximately 15 inches.

31. Raise the tube, keeping the fluid level at the 15 inch mark.

32. Replace the restraints on the siphon tube.

33. Allow the cylinder and sample to stand undisturbed for 20 minutes +/- 15 seconds.

34. After this time take the Clay reading.

35. Read the top of the Clay suspension. (See Figure 4) If the suspension level between lines take the highest reading.

36. Insert the weighted foot assembly. (Refer to the standard test method for specific notes of the weighted foot assemblies.)

37. MAKE SURE THAT YOU DO NOT ALLOW THE INDICATOR TO HIS THE MOUTH OF THE CYLINDER.

38. Lower the assembly into the solution until the foot comes to rest on the sand.

39. Take the sand reading. If the indicator is between 2 lines take the highest reading. (See figure 5.)

40. Record the clay and sand readings.

41. Enter the clay and sand readings in the Sand Equivalency formula and complete the calculations.

Calculations

Calculate the sand equivalent (SE) value to the nearest 0.1 using the following formula:

$$SE = \frac{Sand\,\mathrm{Re}ading x 100}{Clay\,\mathrm{Re}ading}$$

Common Testing Errors

- Calcium Chloride Solution not mixed properly, used outside of the temperature range or not checked for organic growth.
- Vibrations or jarring while sample is settling out in the solution.
- Improper sample preparations (splitting & test sample preparations.)
- Solution exposed to direct sunlight.
- Sample not irrigated correctly.
- Sample not shaker properly in graduated cylinder.

GLOSSARY

Irrigation Tube - Metal tube pushed thru material to help force clay-like material into suspension.

Weighted Foot Assembly - Device used to measure the height of the nonclay-like material.

Siphon Assembly - A gallon container and flexible hose used to introduce the solution into the irrigation tube.

Mechanical Shaker - Used to agitate the sample and solution before irrigation.

Quiz

1. The material shall pass what sieve?

2. Do we use air dried or pre-wet material?

3. How much solution is siphoned into the graduated cylinder before the sample is added?

4. How long is the wetted sample allowed to stand undisturbed before shaking?

5. The irrigation procedure is performed until the solution reaches what height in the graduated cylinder?

6. How long does the cylinder and contents stand undisturbed before you take your readings?

7. What do you do with the readings that fall between the graduations on the graduated cylinder?

FLAT PARTICLES, ELONGATED PARTICLES, OR FLAT AND ELONGATED PARTICLES IN COARSE AGGREGATE

ASTM D 4791

Developed by:

Federal Highway Administration Multi-Regional
Aggregate Training and Certification Group

July, 1999

TABLE OF CONTENT

NOTE

Successful completion of the following training materials, including examination and performance evaluation are prerequisites for this training package.

- ♦ AASHTO D 75, Practice for Sampling Aggregates.
- ♦ ASTM D 3665, Practice for Random Sampling of Construction Materials
- ♦ AASHTO T 248, Reducing Sample of Aggregate to Testing Size.
- ♦ AASHTO T 27, Sieve Analysis of Aggregates.

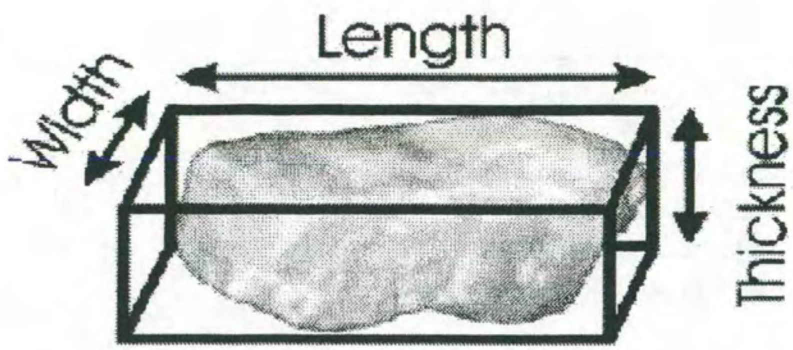
GLOSSARY

Flat and Elongated Particles of Aggregate - Those particles having a ratio of length to thickness greater than a specified value.

Length - the longest dimension.

Thickness - the smallest dimension.

Width - the other dimension.



FLAT PARTICLES, ELONGATED PARTICLES, OR FLAT AND ELONGATED PARTICLES IN COARSE AGGREGATE

This test method covers tests for flat particles, elongated particles, or flat and elongated particles in coarse aggregate. In this text only flat and elongated particles will be covered because at this time the only national specification that references this test is the Superpave Specification, which refers to Flat and Elongated Particles in Coarse Aggregate.

Flat and elongated particles of coarse aggregates have a tendency to fracture more easily than other aggregate particles. When the coarse aggregate does fracture, the gradation will likely change which may be detrimental to the mix. Additionally, flat and elongated particles of aggregate, for some construction uses, may interfere with consolidation and may result in harsh, difficult to place mixtures.

NOTE
This test method is being reviewed and could be changed in the future.

SUMMARY OF TESTING

Individual aggregates of specific sieve sizes are tested for ratios of width to thickness, length to width, or length to thickness. The test is performed on a sample of coarse aggregate reduced from a representative field sample. The sample is sieved to separate each size larger than the 9.5 mm ($^3/_8$ in.) Sieve. Each size is then tested in a proportional caliper device by setting the caliper to the longer dimension and attempting to fit the smaller dimension of the particle through the other caliper gap, which is a prescribed ration smaller then the larger dimension (i.e., a 5:1 ration). Particles are counted or weighed to determine a percentage of flat, elongated, or flat and elongated particle in a sample. Superpave specifications require asphalt mixtures to have less than 10% flat and elongated particles using a 5:1 ration.

Common Testing Errors

Not obtaining a representative sample.

Not reducing the sample properly.

Not sieving to completion.

Improper positioning in the machine.

TESTING METHODOLOGY

Apparatus

The following apparatus is needed to perform the test for flat and elongated particles:

- Proportional Caliper Device.
- Balance - Accurate to 0.5% of the mass of the sample.
- Oven or hot plate (if determination is made by mass).

Note: If the proportional caliper is not used, the degree of error could increase dramatically.

Sampling

Sample the coarse aggregate in accordance with AASHTO T 2. Thoroughly mix the sample and reduce it to an amount suitable for testing using the applicable procedures described in AASHTO T 248.

Sample Size

Set up the test sample according to the following table:

If Maximum Size of the Material is: (retained on)	Then Split Out:
9.5 mm (3/8 in.)	1 kg (2 lb.)
12.5 mm (½ in.)	2 kg (4 lb.)
19.0 mm (3/4 in)	5 kg (11 lb.)
25.0 mm (1 in.)	10 kg (22 lb.)
37.5 mm (1 ½ in.)	15 kg (33 lb.)

Note: This is the entire sample (+4 and -4). Put it in the appropriate size pan (or bag) as needed. It will then be sieved out by size. Mark the work sheet as "Flat and Elongated Particles". (Only test the sizes that are present in the amount of 10% or more of the original sample, in other words the gradation needs to be completed first.)

Test Procedure

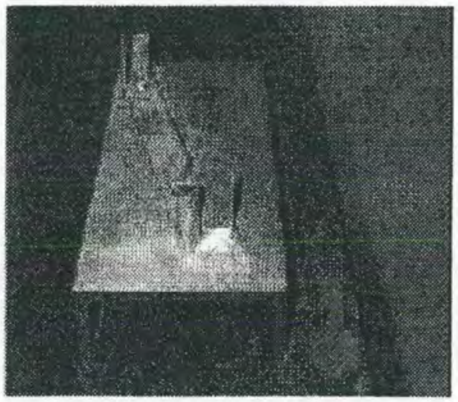
1. If determination by mass is required, oven dry the sample to a constant mass at a temperature of 110° ∓5° C. If determination is by particle count, drying is not necessary.

2. Sieve the sample of coarse aggregate to be tested in accordance with test method AASHTO T 27. Reduce each size fraction larger than the 9.5mm(⅜ in.) sieve that is present in the amount of 10% or more of the original sample in accordance with method AASHTO T 248 until approximately 100 particles are obtained.

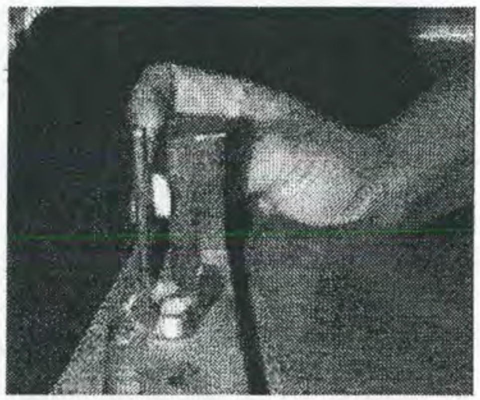
3. Use the proportional caliper device positioned at the 5:1 ratio.

4. Set the larger opening equal to the particles longest dimension. The particle is considered flat and/or elongated if the particles thinnest dimension passed through the smaller opening.

5. Test each of the particles in each size fraction and place in one of two groups: (1) Particles with longest to thinnest ratios over 5:1 and (2) Particles with longest to thinnest ratios less than 5:1.



Checking Elongation



Checking Flatness

6. After particles have been classified into the two groups, determine the proportion of the sample in each group by either count or by mass as required.

Calculation

Calculate the percentage of flat and elongated particles to the nearest 1% for each sieve size greater the 9.5mm(⅜ in.).

Note: *Follow the rounding rules specified by your state.*

Example Calculation

19.0 mm ($^3/_4$ in) Stone

Sieve	25.0 mm	19.0 mm	12.5 mm	9.5 mm
% Passing	100	99.4	75.7	46.4
% Retained	0	0.6	23.7	29.3

No test is performed on the 19.0 mm size aggregate because it is less than 10 percent of the total sample. It will be assumed that the 19.0 mm particles have the same percentage of flat and elongated as the next sieve (12.5 mm).

The 12.5 mm size material totaled 715.3 grams after reducing to approximately 100 particles. 6.9 grams were classified as flat and elongated, therefore, the percent flat and elongated on the 12.5 mm sieve is:

$$\frac{6.9}{715.3} \text{ X } 100 = 1.0\%$$

Likewise, the 9.5 mm size totaled 239.7 grams after reduction and 12.2 grams were classified as flat and elongated. The percent flat and elongated on the 9.5 mm sieve is:

$$\frac{12.2}{239.7} \text{ X } 100 = 5.1\%$$

The percentage of flat and elongated particles on each sieve is reported to the nearest whole percent.

To calculate the weighted average percent flat and elongated particles for the sample, the percentage calculated for each individual sieve needs to be multiplied by the ratio of the percent retained for that sieve to the total percent retained above the 9.5 mm sieve and the results totaled for all sieves.

The total percent retained for the example is 53.6%. The percent flat and elongated on the 19.0 mm sieve is assumed to be 1.0% (same as the 12.5 mm size). The percent retained on the 19.0 sieve is 0.6%, therefore, to calculate the weighted average percent:

$$(1.0)\frac{0.6}{53.6} = 0.0\%$$

For the 12.5 mm sieve the weighted average percent is:

$$(1.0)\frac{23.7}{53.6} = 0.4\%$$

And for the 9.5 mm sieve the weighted average percent is:

$$(5.1)\frac{29.3}{53.6} = 2.8\%$$

Finally, the weighted average percent flat and elongated particles in the coarse aggregate is determined by adding the weighted average percent for each sieve:

$$0.0 + 0.4 + 2.8 = 3.2\%$$

For reporting, round the result to the nearest whole percent.

FLAT AND ELONGATED PARTICLES (ASTM D 4791) WORKSHEET

Project ___Example___ Mix Design ID __________ Date __________

Material/Stockpile ID __________ Technician __________

Sieve Sizes	Original Percent Retained	Mass Tested grams	Mass Failing 5:1 ratio (g)	%Flat &Elong. Individual sieve	%Flat & Elong. Weighted Ave.
	A	**B**	**C**	**D**	**E**
37.5 mm (1 ½ in.)					
25.0 mm (1 in.)					
19.0 mm ($^3/_4$ in.)	0.6	NA	NA	1.0	0.0
12.5 mm (½ in.)	23.7	715.3	6.9	1.0	0.4
9.5 mm ($^3/_8$ in.)	29.3	239.7	12.2	5.1	2.8
Total % Retained	53.6			Total	3.2

Remarks: Example

Weighted average percent Flat & Elongated particles = 3%

FLAT AND ELONGATED PARTICLES (ASTM D 4791) WORKSHEET

Project____________________ Mix Design ID __________________ Date __________

Material/Stockpile ID ________________________ Technician ____________________

Sieve Sizes	Original Percent Retained	Mass Tested grams	Mass Failing 5:1 ratio (g)	%Flat &Elong. Individual sieve	%Flat & Elong. Weighted Ave.
	A	**B**	**C**	**D**	**E**
37.5 mm (1 ½ in.)	______	______	______	______	______
25.0 mm (1 in.)	______	______	______	______	______
19.0 mm ($^3/_4$ in.)	______	______	______	______	______
12.5 mm (½ in.)	______	______	______	______	______
9.5 mm ($^3/_8$ in.)	______	______	______	______	______
Total % Retained	______			Total	______

Remarks: ____

____

____

DETERMINING PERCENT OF FRACTURED PARTICLES IN COARSE AGGREGATE

ASTM D 5821

Multi-Regional Training and Certification

FHWA SPONSORED

Developed by
FHWA Multi-regional Aggregate Training & Certification Group

July, 1999

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NOTE

Successful completion of the following training materials, including examination and performance evaluation are prerequisites for this training package.

Reference ASTM Standard Tests

- ASTM C 136 Test Method for Sieve Analysis of Fine and Coarse Aggregate
- ASTM C 702 Practice of Reducing Field Samples of Aggregate to Test Size
- ASTM D 75 Practice of Sampling Aggregate

Reference AASHTO Tests to ASTM Standard Tests Listed Above

- AASHTO T 2 is identical to ASTM D 75
- AASHTO T 248 is identical to ASTM C 702
- AASHTO T 27 does differ slightly with ASTM C 136

SCOPE

This test procedure determines the amount (percent) of fracture faced rock particles, by visual inspection that meets specific requirements. The fractured face of each rock particle must meet a minimum cross-sectional area (See Terminology). Specifications contain requirements for percentage of crushed rock particles, with the purpose of maximizing shear strength in either bound or unbound aggregate mixtures. This method can be used in determining the acceptability of coarse, dense-graded, and open-graded aggregates with respect to such requirements. This procedure is used primarily for bituminous aggregates.

TERMINOLOGY

Fractured Face - A fractured face is defined as being caused either by mechanical means or by nature and should **have sharp or slightly blunted edges**. Natural fractures, to be accepted, must be similar to fractures produced by a crusher. A broken surface constituting an area equal to at least 25% of the projected area of the particle, as viewed perpendicular to (looking directly at) the fractured face.

Fractured Rock Particle - A rock particle having at least one fractured face, or two fractured faces, as required for that class/type of aggregate in the specifications.

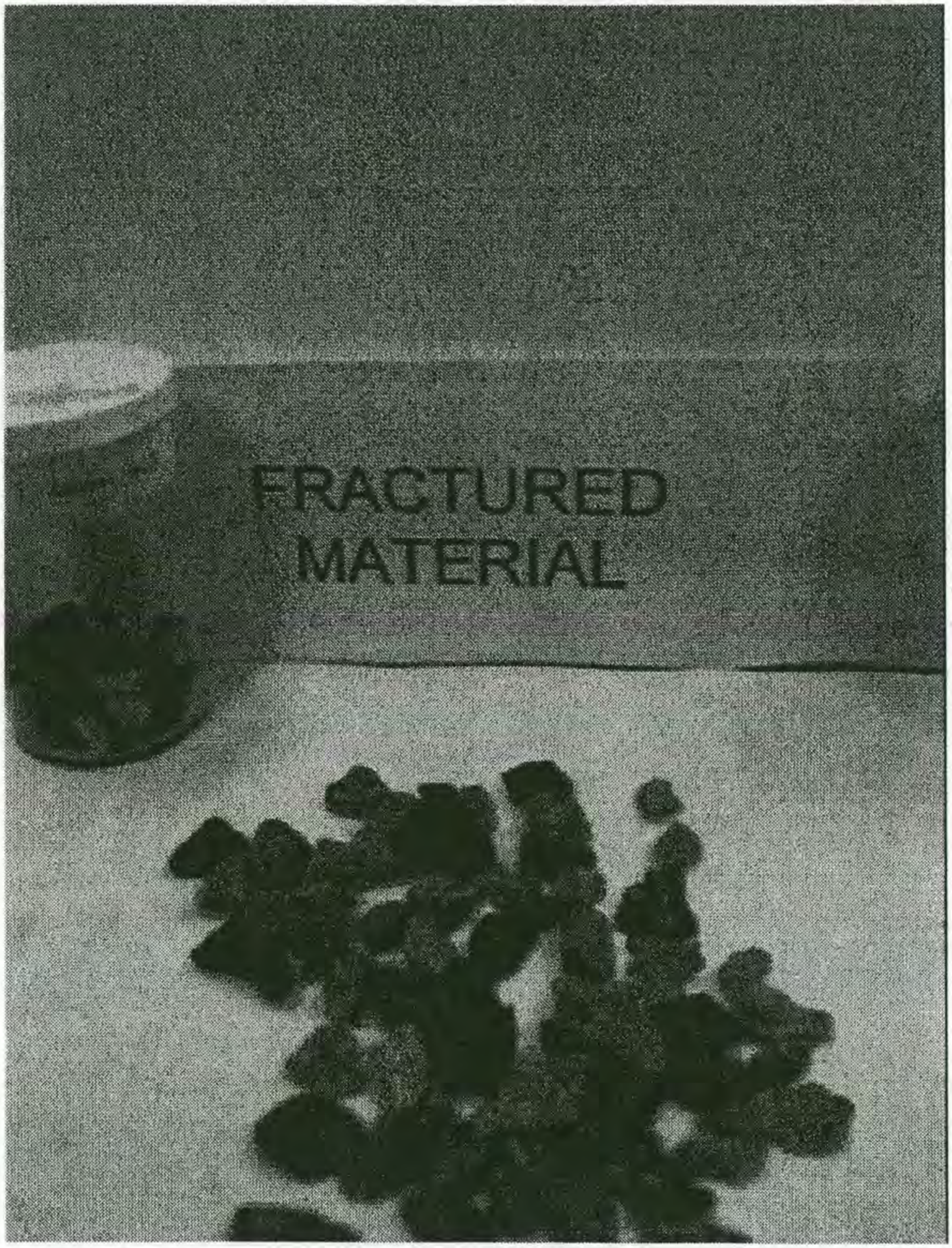
EQUIPMENT

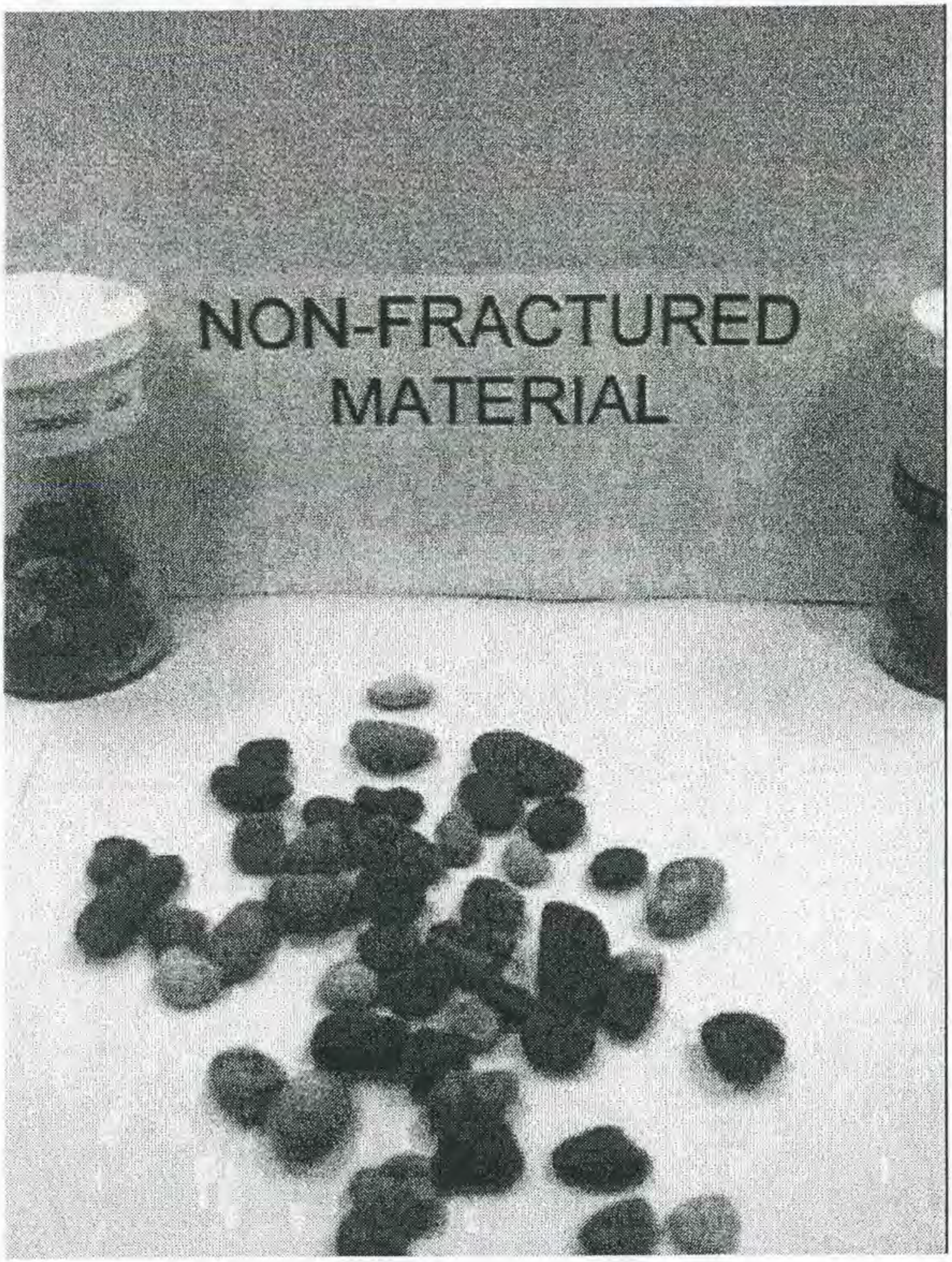
A. Sieves - A set of sieves appropriate for the sample type.

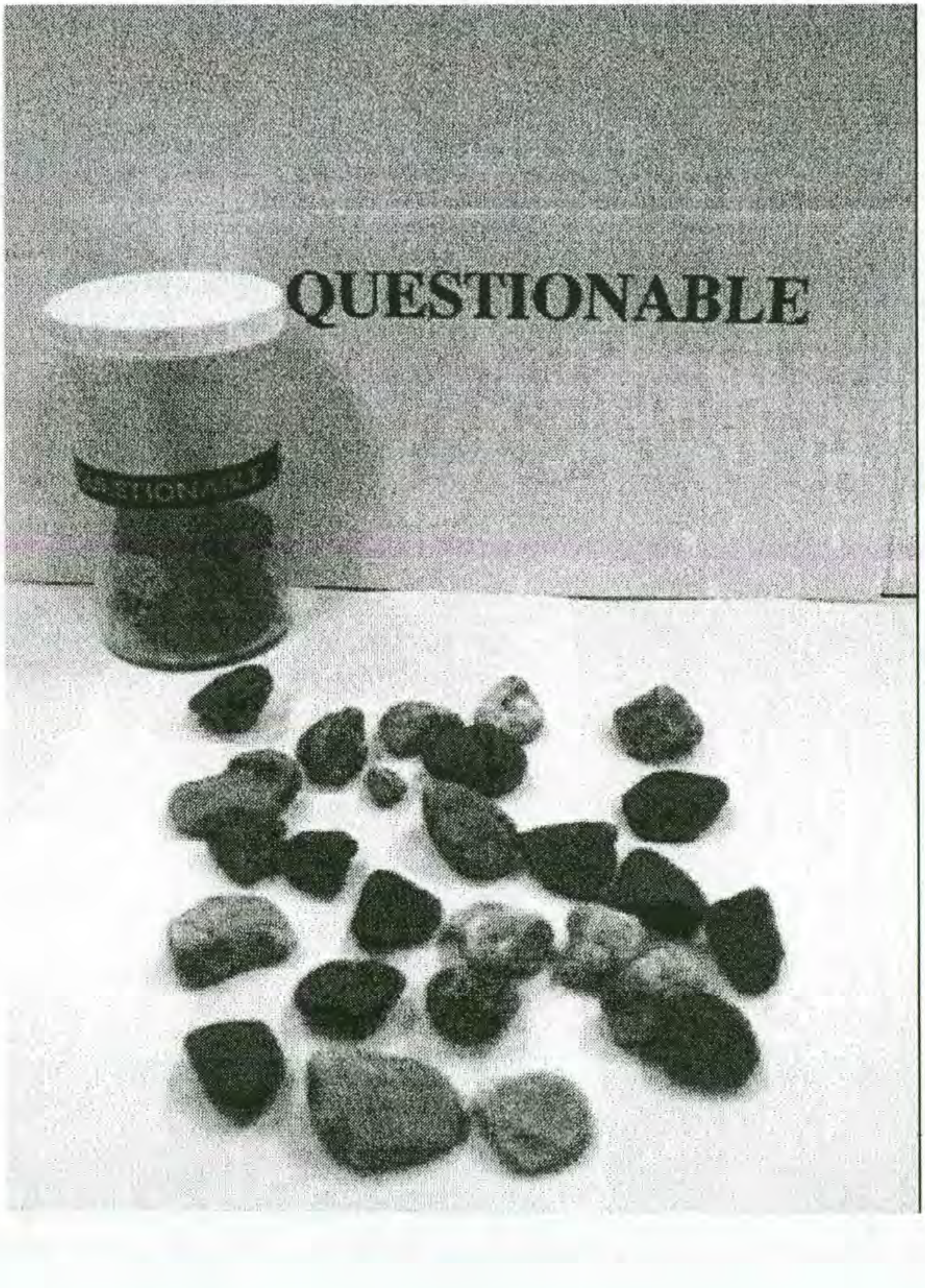
B. Balance - appropriate for the size of sample and accurate to 0.1g.

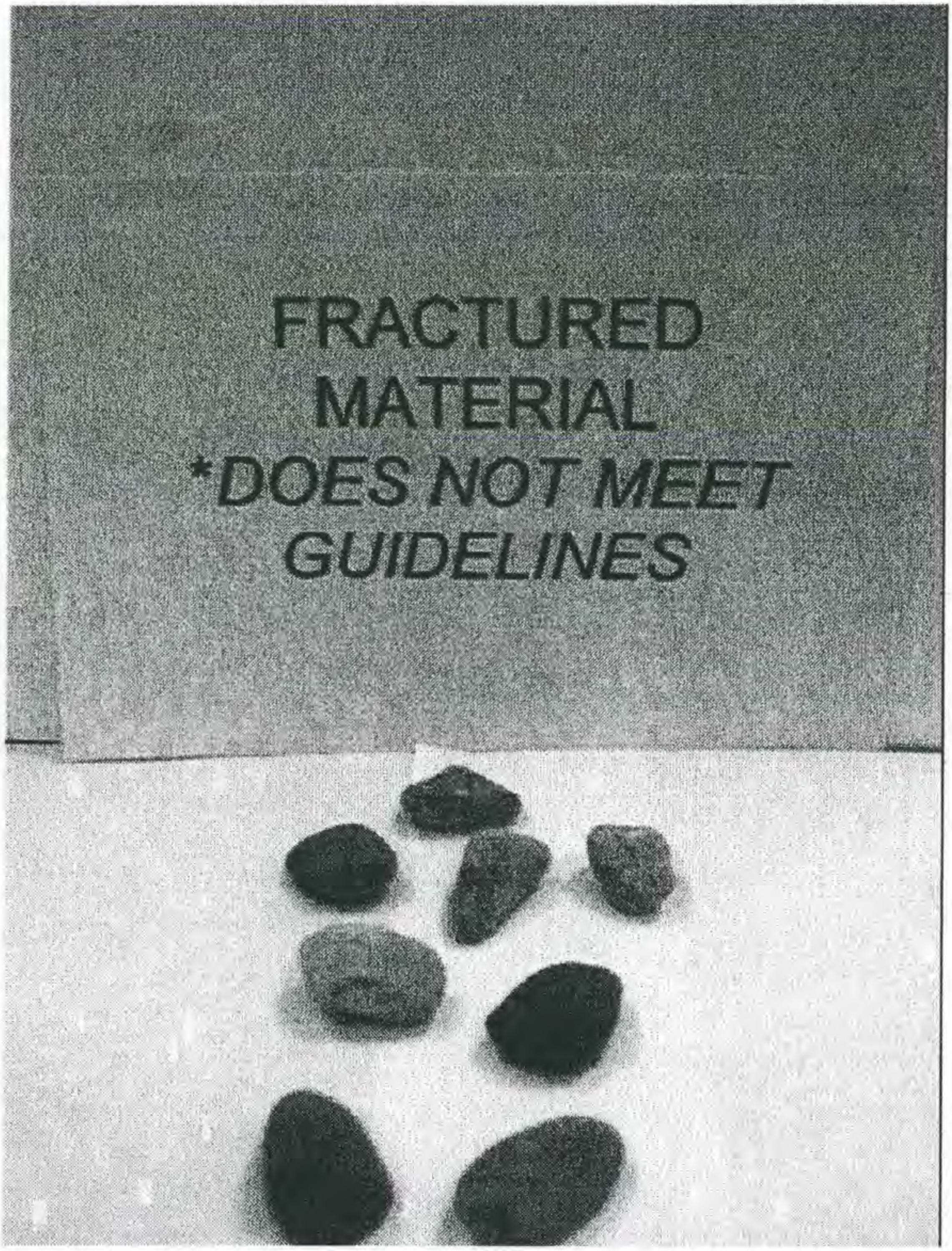
C. Spatula or similar tool to aid in sorting the aggregate particles.

D. Paper Containers.


FRACTURED
MATERIAL


NON-FRACTURED
MATERIAL


QUESTIONABLE
QUESTIONABLE


FRACTURED
MATERIAL
*DOES NOT MEET
GUIDELINES

SAMPLE PREPARATION

Air-dry the representative sample prior to the coarse gradation process so that there is a clean separation of the particles. A total + 4.75 mm (No. 4) sample could be set up for testing or more commonly the + 4.75 mm (No. 4) material will be split into representative fractions. It will be necessary to determine the correct proportions between the two fractions and this may be calculated from gradation results. All the material passing and retained on the appropriate sieves for the selected fractions are weighed and the sum of the weights equal the total +4.75 mm (No. 4) material. Then the material from each fraction is split down to the required sample size and tested or any other method that maintains the proportional relationship between the two or more fractions and provides a representative sample for each fraction.
See table below for *nominal maximum sieve sizes and minimum sample sizes.

SPLIT SAMPLE AND SINGLE SAMPLE SIZES

SIEVE SIZE	SIZE SIEVE	SAMPLE SIZE PERCENT CRUSHED ONLY	
mm	Inch	(grams)	(lbs)
9.5 - 4.75 19.0 - 9.5	3/8" - #4 3/4 – 3/8"	450 – 550 1500 – 2000	1 4 – 5
12.5 - 4.75 19.0 - 12.5	1/2" - #4 3/4 – 1/2"	900 – 1100 1500 – 2000	2 – 3 4 – 5
MAXIMUM NOMINAL SIEVE SIZES	**MAXIMUM NOMINAL SIEVE SIZES**	**SAMPLE SIZE PERCENT CRUSHED ONLY**	
mm	**Inch**	**(grams)**	**(lbs)**
9.5	3/8"	450 – 550	1
12.5	1/2"	900 – 1100	2 – 3
19.0	¾"	1500 – 2000	4 – 5
25.0	1"	3000±	6 – 7
37.5	1½"	7500±	16 – 17

**** NOTE: Nominal maximum sieve size is defined as the largest sieve size listed in the applicable specification upon which any material is permitted to be retained.***

TEST PROCEDURE

A. Wash and then dry to a constant mass (weight). Weigh the test sample to the nearest 0.1g and record as "Test Sample Weight".

B. Spread the test sample on a clean, flat surface large enough to permit the material to be spread thinly for careful inspection and evaluation.

C. Using the spatula or a similar tool separate the particles into one of the following three categories.

1. **Crushed Particles**, using the criteria of "one or more fractured faces" or "two or more fractured faces" as is consistent with the requirements in the specifications.

2. **Uncrushed Particles**

3. **Questionable Particles,** referring to the criteria listed under Fractured Face (page 4), the rock particle is boarder line in meeting fractured face area or the fractured area is natural and has rounded edges.

D. Determine the mass (weight) of the "Crushed Particles" and "Questionable Particles" separately and record the weights as "Weight of Crushed Particles" and "Weight of Questionable Particles".

> **NOTE:**
> The mass (weight) of the Questionable Particles (QP) shall not exceed 20% of the total Test Sample Weight (TSW). If the QP mass (weight) is larger than 20% of the TSW, re-evaluate all the QP making a closer decision concerning crushed/non-crushed, so that the

COMMON TESTING ERRORS

- Sample not representative
- To many questionable particles

CALCULATION

A. Calculate the percentage of crushed particles for each separate fraction as follows:

$$\text{Percent Crushed Particles } (\mathbf{CP}) = \frac{A + (B \div 2)}{C} \times 100$$

Where:

A = Weight of crushed particles with at least the specified number of fractured faces, in grams.

B = Weight of questionable particles, in grams.

C = Weight of the test sample, in grams.

In the example, 19.0 to 9.5 mm (3/4 to 3/8") size:

A = 730
B = 104
C = 1850

$$\mathbf{CP} = \frac{730 + (104 \div 2)}{1850} \times 100 = 42.3\%$$

In the example, 9.5 to 4.75 mm (3/8" – No. 4) size:

A = 350
B = 70
C = 470

$$\mathbf{CP} = \frac{350 + (70 \div 2)}{470} \times 100 = 81.9\%$$

B. Total Percentage of Crushed Particles (**TPC**) Retained on the 4.75mm (No. 4) Sieve.

Determine the percentages of the 19.0 to 9.5 mm (3/4 to 3/8") and the 9.5 to 4.75 mm (3/8" to No. 4) fractions using the material retained on the 4.75 mm (No. 4) sieve as 100%.

Example:

19.0 - 9.5 mm (3/4 - 3/8") Material	=	3766g
9.5 - 4.75 mm (3/8 – No. 4) Material	=	7314g
Total +4.75 mm (No. 4) Material	=	11080g

$$\text{Percent } 19.0 - 9.5 \text{ mm } (3/4 - 3/8")= \frac{3766}{11080} \times 100 = 34\%$$

$$\text{Percent } 9.5 - 4.75 \text{ mm } (3/8" – \text{No. } 4) = \frac{7314}{11080} \times 100 = 66\%$$

Total Percent Crushed Particles (**TPC**) =

(% Crushed Particles 19.0 – 9.5 mm [3/4 to 3/8"]) **x**
(% of 19.0 - 9.5 mm [3/4 to 3/8"] Material)

+

(% Crushed Particles 9.5 - 4.75 mm [3/8" – No. 4]) **x**
(% of 9.5 - 4.75 mm [3/8" – No. 4] Material)

In the Example:

(0.423 **x** 0.34) **+** (0.819 **x** 0.66) =

(0.144) **+** (0.541) = 68.5% (**TPC**)

Bulk Specific Gravity

$$G_{sb} = \frac{\text{Dry Mass}}{\text{Bulk Vol}} \Big/ 1.000 \text{ g/cm}^3$$

Bulk Volume = solid volume + water permeable pore volume

"SSD" Level

water permeable pore volume

Apparent Specific Gravity

$$G_{sa} = \frac{\text{Dry Mass}}{\text{App Vol}} \Big/ 1.000 \text{ g/cm}^3$$

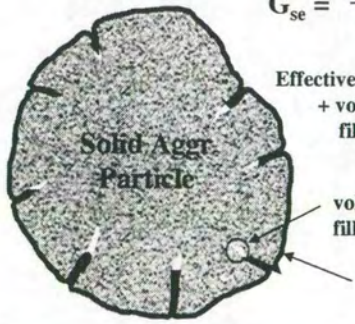
Apparent Volume = volume of solid aggr particle

Apparent volume <u>does not</u> include volume of surface pores

Effective Specific Gravity

$$G_{se} = \frac{\text{Dry Mass}}{\text{Eff Vol}} \Big/ 1.000 \text{ g/cm}^3$$

Effective Volume = volume of solid aggr particle + volume of water permeable pores not filled with asphalt



Aggregate Effective Specific Gravity

$$G_{se} = \frac{100 - P_b}{\dfrac{100}{G_{mm}} - \dfrac{P_b}{G_b}}$$

Example Calculation

Knowns:

Mixed with 5% asphalt binder
Gmm = 2.535
Gb = 1.03

Then:

$$G_{se} = \frac{100 - 5.0}{\frac{100}{2.535} - \frac{5.0}{1.03}} = 2.770$$

Aggregate Specific Gravity

- **G_{sb} - lowest value**
- **G_{se} - middle value**
- **G_{sa} - highest value**

Approximation

$$Gse \cong Gsb + 0.8(Gsa - Gsb)$$

Approximation used in Gyratory when Gmm is unknown.

Factor 0.8 can vary. 0.5-0.6 may give closer approximation.
Use your knowledge of your materials.

Specific Gravity of Combined Aggregate

$$G_{sb} = \frac{P_1 + P_2 + \ \dots \ + P_n}{P_1/G_1 + P_2 / G_2 + \dots + P_n / G_n}$$

Rev 01/98

Form E235

QMA INTERLABORATORY CORRELATION

Project No.: NHS-6-3(41)--12-77
Contractor: QUALITY ASPHALT INC.
Page: 1 OF 1

County: POLK
Dist. Lab: DIST. 1
Gmb. Tolerance: + or - .020

Contract ID.: 77-0006-41
Target % Pa: 4.0
Gmm. Tolerance: + or - .010

Date	Test No.	TYPE OF MIX	Gmb - Data			Gmm - Data			Pa - Data		
			D.O.T.	Contr.	Diff.	D.O.T.	Contr.	Diff.	D.O.T.	Contr.	DIFF.
06/18/98	SU6-18A	SURFACE 30M	2.385	2.373	0.012	2.475	2.469	0.006	3.6	3.9	0.3
06/19/98	SU6-19A	SURFACE 30M	2.388	2.369	0.019	2.481	2.469	0.012	3.7	4.1	0.4
06/19/98	SU6-19C	SURFACE 30M	2.384	2.373	0.011	2.487	2.480	0.007	4.1	4.3	0.2

STANDARD METHOD FOR PREPARING AND DETERMINING THE DENSITY OF HOT MIX ASPHALT (HMA) SPECIMENS BY MEANS OF THE SHRP GYRATORY COMPACTOR

AASHTO TP4

Multi-Regional Training and Certification

M-TRAC

FHWA SPONSORED

Developed by
FHWA Multi-Regional Asphalt Training and Certification Group

December 17, 1998

NOTE

Successful completion of the following training materials, including examination and performance evaluation, is a prerequisite for this training package.

AASHTO T 168, Sampling Bituminous Paving Mixtures

AASHTO PP 2, Short and Long Term Aging of Hot Mix Asphalt

GLOSSARY

Corrected relative density (C_x) = the density of a specimen determined at x number of gyrations and expressed as a percentage of the maximum theoretical specific gravity of the mixture, corrected for the fact that the cylinder is not a smooth sided cylinder.

N-initial ($N_{in}i$) = the initial number of gyrations, a relatively low number of gyrations determined based on climate and traffic volume and used to analyze the early densification properties of the hot mix asphalt during construction

N-design (N_{des}) = the design number of gyrations, also determined based on climate and design traffic level and used for design of the asphalt mixture.

N-maximum (N_{max})= the maximum number of gyrations applied to a specimen, determined based on the climate and design traffic volume and used to assess the densification properties of the mixture after many years in service.

PREPARING AND DETERMINING THE DENSITY OF HMA SPECIMENS BY MEANS OF THE SHRP GYRATORY COMPACTOR

Compacted samples of hot mix asphalt (HMA) are used to determine the volumetric and mechanical properties of the mixture during the mix design phase and for quality control/quality assurance during construction. These volumetric and/or mechanical properties are then evaluated to select a mix design or control the mixture during production. The specimens produced with the gyratory compactor simulate the density, aggregate orientation and structural characteristics of this mixture in the actual roadway.

The gyratory compactor is used to prepare specimens for later analysis of the volumetric properties of the mixture, evaluation of mixture densification properties, evaluation of moisture sensitivity, field quality control, or other testing purposes.

This text will explain the method of compacting samples of hot mix asphalt and determining their percent compaction using the SHRP gyratory compactor. This method may be used with laboratory fabricated specimens, as in the mix design process, or with plant-mixed material during construction.

Common Testing Errors

- Not placing a paper protection disk on the bottom or top of the specimen.
- Not compacting the mixture at the proper temperature.
- Not properly verifying the calibration of the compactor prior to use.
- Not leveling off the specimen using dwell gyrations or a square load.
- Not removing the paper disks while specimen is still warm.
- Not preheating the mold and base plate.
- Not charging the mold with mix quickly, in one lift without spading or rodding.

TEST METHODOLOGY

Apparatus

- Superpave Gyratory Compactor, including a device for measuring and recording the height of the specimen throughout the compaction process. The compactor may also include a printer or a computer and software for collecting and printing the data.
- Specimen molds
- Thermometer
- Balance readable to 1 gram
- Oven
- Calibration equipment recommended by compactor manufacturer
- Safety equipment: insulated gloves, long sleeves, etc.
- Miscellaneous equipment: paper disks, lubricating materials recommended by compactor manufacturer, scoop or trowel for moving mixture, funnel or other device for ease of loading mixture into mold (optional).

Calibration

The means of calibrating the gyratory vary with different manufacturers. Refer to the operation manual of the particular brand and model of gyratory available for use. Calibration of the following items should be verified at the noted intervals or according to manufacturers' recommendations:

Item	Tolerance	Calibration Interval
Height	Record to nearest 0.1 mm, Compact to 115 $\pm$ 5 mm	Daily
Angle	1.25° $\pm$ 0.02°	Every 1-3 months
Pressure	600 $\pm$ 18 kPa	Every 6 months
Speed of Rotation	30.0 $\pm$ 0.5 gyrations per minute	After mechanical changes or every 6 months

Mold and platen dimensions, hardness and smoothness should also be verified. Oven temperature should be verified; oven must be capable of maintaining the temperature as required for PP2, *Practice for Short and Long Term Aging of Hot Mix Asphalt (HMA)*.

Sample Preparation

Samples for compaction in the gyratory may be obtained in one of two ways; mixture may be prepared in the laboratory or plant-mixed material may be obtained from roadway or truck samples.

For the determination of volumetric properties for mix design or quality control, a finished specimen height of 115 ± 5 mm is desired. When producing specimens for testing under AASHTO T283, *Resistance of Compacted Bituminous Mixture to Moisture Induced Damage*, a finished specimen height of 95 mm is required and for Superpave mix analysis, a specimen height of 140 mm is desired. In these two cases, the batch weights must be varied to provide the desired specimen height at a specified air void content; samples are then compacted to the specified height rather than a fixed number of gyrations. (See AASHTO T283 for more details.)

Laboratory Prepared Materials

Preparing samples of mixture in the laboratory requires batching out the aggregates, mixing in the proper amount of asphalt binder, aging the prepared mixture, heating the mixture to compaction temperature and compacting the specimen. The steps involved in preparing the mixture in the laboratory are as follows:

1. Weigh out the appropriate amounts of the required aggregate size fractions and combine in a bowl to the proper batch weight. Typically, a batch weight of 4500 - 4700 grams of aggregate will provide enough material for a finished specimen height of 115 ± 5 mm, if the combined aggregate specific gravity is between 2.55 - 2.70.

2. Heat the asphalt binder and the combined aggregate in an oven to the appropriate mixing temperature for the binder to be used. This temperature can be determined from an equi-viscous temperature chart or may be provided by the binder supplier. The appropriate temperature range for mixing is defined as the range of temperatures that produces a viscosity of 0.17 ± 0.02 Pa•s for the unaged binder. This ensures that the binder is fluid enough to coat the aggregate particles. Some modified binders do not follow these temperature-viscosity relationships; the manufacturer's recommendations should be followed.

3. The heated aggregate should be placed in the mixing bowl and thoroughly dry mixed. Make a crater in the center of the aggregate in the bowl and weigh in the required amount of asphalt binder. Begin mixing immediately.

4. A mechanical mixer is recommended for preparing laboratory mixtures because mixing such a large quantity of material by hand is difficult. Mixing should continue until the asphalt binder is uniformly distributed over the aggregate particles.

5. After mixing, spread the loose mixture in a flat, shallow pan and short-term age the mixture as detailed in PP2, *Practice for Short and Long Term Aging of Hot Mix Asphalt (HMA)*.

6. Determine the proper compaction temperature range for the asphalt binder used. This is defined as the range of temperatures that yields a binder viscosity of approximately 0.28 ± 0.03 Pa•s. Modified binders may not conform to these mixing and compaction temperatures, so the manufacturer's recommendations should be followed.

7. Place the compaction mold and base plate in an oven to preheat at the required compaction temperature for a period of 30 to 60 minutes prior to the start of compaction.

8. Following the short-term aging period, bring the mixture to the proper compaction temperature, if different from 135°C (275°F), by placing it in another oven at the compaction temperature for up to 30 minutes.

9. After the mixture comes to the proper compaction temperature, proceed with compaction in the gyratory as outlined below.

Plant-Mixed Materials

When plant-mixed materials are sampled from the roadway or truck, no short-term aging is required. The mixture must be brought to the proper compaction temperature then compacted and analyzed as described below. Place the material in an oven at the compaction temperature and bring the mixture to the proper temperature by careful, uniform heating. The mix should be stirred periodically to help assure uniform heating. In general, the shortest heating time that will bring the mixture to the compaction temperature is preferred. Avoid over-heating the mix. When the compaction temperature has been reached, proceed with specimen compaction as outlined below.

Procedure

Once the mixture sample has reached the proper compaction temperature, it is compacted in the gyratory. For most purposes, the finished specimens will be used to calculate volumetric properties and the specimens will be compacted to a fixed number of gyrations. When preparing specimens for testing under AASHTO T283, *Resistance of Compacted Bituminous Mixture to Moisture Induced Damage*, or in Superpave mix analysis, specimens may be compacted to a fixed height to produce a specified air void content.

The procedure to compact to a fixed number of gyrations is as follows:

1. Ensure that the gyratory compactor has been turned on and allowed to warm up for the time recommended by the manufacturer. Verify all settings for angle, pressure and number of gyrations.

2. Verify that height recording device is turned on and is reading in the proper units. Height calibration should be verified daily.

3. When the compaction temperature has been reached, remove the mold and base plate from the oven. Put the base plate in position in the mold and place a paper disk in the bottom of the mold.

4. Charge the mixture into the mold in one lift. A funnel or other device may be used to place the mixture into the mold. Take care to avoid segregating the mix in the mold, but work quickly so that the mixture does not cool excessively during loading. Level the mix in the mold and place a paper disk on top.

5. Place the mold in the gyratory as per manufacturer's recommendations. (Some gyratories allow charging the mold with mix after the mold has been positioned in the compactor.) Lubricate the mold or gyratory parts as recommended by the manufacturer.

6. Apply the load to the mixture in the mold according to manufacturer's recommendations. The pressure applied should be 600 ± 18 kPa.

7. Apply the gyratory angle of 1.25° ± 0.02° to the specimen.

8. Input the desired number of gyrations (N_{max}) to apply on the gyratory control pad. Start the compaction process and compact to the required number of gyrations. The number of gyrations to apply is determined from the following table and is based on the average high air temperature at the project location and the expected design traffic volume in Equivalent Single Axle Loads (ESALs); this information is usually provided in the contract documents. Compact to N_{max}. Volumetric and densification properties are determined at N_{ini} and N_{des} as well as N_{max}, as described on the following page.

Design ESALs[1] (million)	Compaction Parameters			Typical Roadway Application[2]
	$N_{initial}$	N_{design}	N_{max}	
<0.3	6	50	75	Applications include roadways with very light traffic volumes such as local roads, county roads, and city streets where truck traffic is prohibited or at a very minimal level. Traffic on these roadways would be considered local in nature, not regional, intrastate, or interstate. Special purpose roadways serving recreational sites or areas may also be applicable to this level.
0.3 to < 3	7	75	115	Applications include many collector roads or access streets. Medium-trafficked city streets and the majority of county roadways may be applicable to this level.
3 to < 30	8	100	160	Applications include many two-lane, multilane, divided, and partially or completely controlled access roadways. Among these are medium to highly trafficked city streets, many state routes, US highways, and some rural interstates.
≥ 30	9	125	205	Applications include the vast majority of the US Interstate system, both rural and urban in nature. Special applications such as truck-weighing stations or truck-climbing lanes on two-lane roadways may also be applicable to this level.

(1) Design ESALs are the anticipated project traffic level expected on the design lane over a 20-year period. Regardless of the actual design life of the roadway, determine the design ESALs for 20 years, and choose the appropriate N_{design} level.

(2) Typical Roadway Applications as defined by A Policy on Geometric Design of Highway and Streets, 1994, AASHTO.

Note: When specified by the agency and the top of the design layer is ≥ 100 mm from the pavement surface and the estimated design traffic is ≥ 0.3 million ESALs, decrease the estimated design traffic level by one, unless the mixture will be exposed to significant main line and construction traffic prior to being overlaid. If less than 25 % of the layer is within 100 mm of the surface, the layer may be considered to be below 100 mm for mixture design purposes.

Note: When the design ESALs are between 3 to < 10 million ESALs the agency may, at their discretion, specify $N_{initial}$ at 7, N_{design} at 75, and N_{max} at 115, based on local experience.

9. The gyratory will stop automatically when the specified N_{max} has been reached. Remove the angle from the specimen and raise the loading ram if needed (this is done automatically on some gyratories).

10. Remove the mold from the compactor, if required, and extrude the specimen from the mold. Take care not to distort the specimen when removing the specimen from the mold. A cooling period of 5 to 10 minutes may be necessary with some mixtures; a fan may help speed the cooling process. Remove the paper disks while the specimen is still warm to avoid excessive sticking.

Density Procedure

When compacting specimens for the determination of volumetric properties for mix design or quality control/quality assurance, it is necessary to determine the specimen height and bulk specific gravity and mixture maximum theoretical specific gravity. This requires the following additional steps:

1. Prepare a loose sample of the same mixtures and determine the maximum theoretical specific gravity (G_{mm}) in accordance with AASHTO T209, *Maximum Specific Gravity of Bituminous Paving Mixtures*.

2. Using the gyratory's height recording system, record the height of the specimen to the nearest 0.1 mm after each gyration.

3. Measure and record the mass of the compacted specimen to the nearest 1 g. Determine the bulk specific gravity (G_{mb}) of the compacted specimen in accordance with AASHTO T166, *Bulk Specific Gravity of Compacted Bituminous Paving Mixtures Using Saturated Surface Dry Specimens*.

Calculations

Using the measured bulk specific gravity of the final compacted specimen and the measured maximum specific gravity of a loose sample of the mixture, and knowing the height of the specimen at different numbers of gyrations, it is possible to calculate the corrected relative density of the specimen. The corrected relative density at any number of gyrations is expressed as a percentage of the maximum theoretical specific gravity for the mix. This allows a determination of the air void content of the specimen at any number of gyrations (as 100% - corrected relative density).

Calculate the corrected relative density of the specimen at any number of gyrations as follows:

$$C_x = (G_{mb}h_m/G_{mm}h_x)\times 100\%$$

where:

C_x	=	Corrected relative density expressed as a percentage of the maximum theoretical specific gravity
G_{mb}	=	Bulk specific gravity of the extruded specimen (determined using T166)
G_{mm}	=	Maximum theoretical specific gravity of the mixture (determined according to T209)
h_m	=	Height of the extruded specimen in millimeters
h_x	=	Height of the specimen during compaction at x gyrations, in millimeters

Report the relative density, C_x, to the nearest 0.1 percent.

[Note: the relative density is described as "corrected" because of the assumptions that underlie the calculations. The calculation of the volumetric properties of the compacted specimen at any point in the compaction process begins with the assumption that the specimen is a smooth sided cylinder 150mm in diameter with a height equal to the specimen height at the number of gyrations of interest, typically N_{ini}, N_{des} or N_{max}. The uncorrected bulk specific gravity of the specimen can then be calculated based on the measured mass of the specimen and the volume of a smooth sided cylinder. The actual bulk specific gravity of the specimen is measured at N_{max} according to AASHTO T166. The uncorrected bulk specific gravity of the specimen is also calculated at N_{max}. The ratio of the measured bulk specific gravity to the uncorrected bulk specific gravity at N_{max} can be used as a correction factor to backcalculate the corrected bulk specific gravity at any number of gyrations. Using the correction factor corrects for the fact that the compacted specimen is not a smooth sided cylinder but does in fact have some surface irregularities and open texture. In other words, the actual volume of the specimen is less than the volume of a smooth sided cylinder due to this surface texture. The corrected bulk specific gravity of the specimen, then, is actually greater than the uncorrected bulk specific gravity because the volume is smaller. These assumptions and calculations are implicitly included in the calculations as described here.]

Example:

Given:

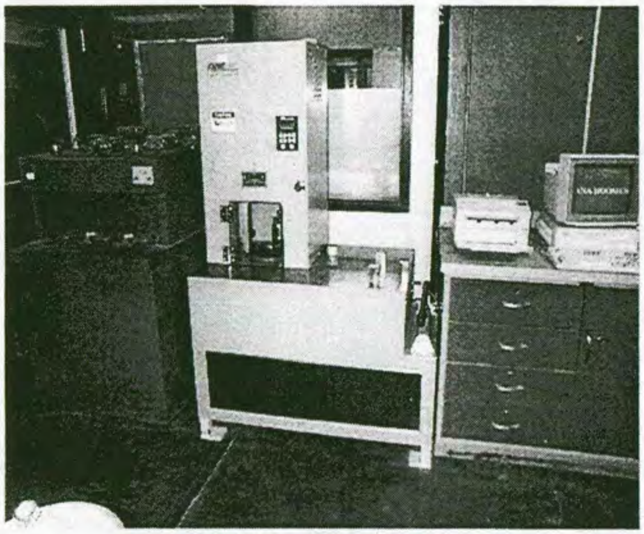
G_{mb}, measured bulk specific gravity = 2.369
G_{mm}, maximum theoretical specific gravity = 2.403
h_m, height of extruded specimen = 117.5 mm

Calculate C_x at N_{ini} = 8 gyrations, h_8 = 135.4 mm
N_{des} = 109, h_{109} = 119.4 mm
N_{max} = 174, h_{174} = 117.5 mm

$$C_8 = (2.369\times 117.5\text{ mm}/2.403 \times 135.4\text{ mm})\times 100\% = 85.6\%$$

$$C_{109} = (2.369\times 117.5\text{ mm}/2.403 \times 119.4\text{ mm})\times 100\% = 95.3\%$$
$$C_{174} = (2.369\times 117.5\text{ mm}/2.403 \times 117.5\text{ mm})\times 100\% = 98.6\%$$

GYRATORY COMPACTOR



Gyratory Compactor

Pouring Mix Into The Mold

Placing Mold Into The Compactor

Mold In The Compactor Ready To Test

Bulk Specific Gravity of Compacted Bituminous Mixtures (AASHTO T166)

- **Purpose**
  - Determine Gmb and density of compacted specimens
  - Used in volumetric analysis
- Apparatus
  - Balance
  - Oven
  - Sample Basket
  - Water Bath

BSG of Compacted HMA

- **AC mixed with agg. and compacted into sample**

$$G_{mb} = \frac{\text{Mass agg. and AC}}{\text{Vol. agg., AC, air voids}}$$

Testing

- **Mixing of asphalt and aggregate**
- **Compaction of sample**
- **Mass of dry sample**
- **Mass under water**
- **Mass saturated surface dry (SSD)**

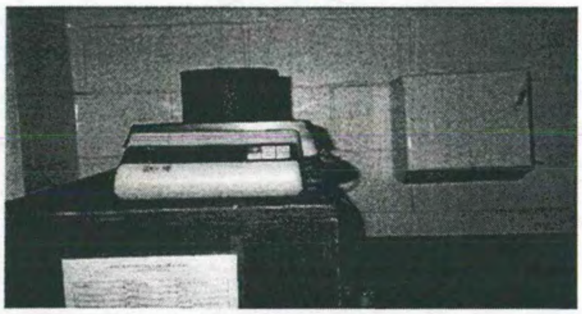
Sample Preparation (T166)

- Compacted specimens (Marshall or SGC) or field cores
- Field cores must be dried at 52±3°C to constant mass

Test Procedure (T166)

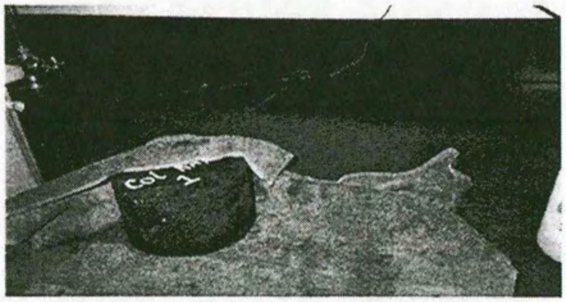
- Dry to constant mass, cool to room temp and record mass in air to 0.1g (**A**)
- Place in basket, immerse in water at 25±1°C for 4±1 minute, record mass in water to 0.1g (**C**)
- Remove and damp dry (SSD) by blotting with damp towel, record SSD mass to 0.1g (**B**)

Testing



Obtain mass of dry compacted sample

Testing



Obtain mass of specimen at SSD

Calculations

- $G_{mb} = A / (B - C)$

  Where:

  A = mass of dry sample

  B = mass of SSD sample

  C = mass of sample under water

Calculations (T166)

- Bulk Specific Gravity, Gmb = A/(B-C)
- Density = Gmb×γ_{water}
- % Water Absorption = [(B-A)/(B-C)]×100
  - if >2%, use T275
- Report all gravities to 0.001

Maximum Specific Gravity of Bituminous Mixtures (Rice) (AASHTO T209)

- **Purpose**
  - Determine Gmm
  - Used in volumetric analysis
- **Apparatus**
  - Container (bowl or flask)
  - Vacuum and manometer
  - Water Bath
  - Balance
  - Oven
  - 1/4" sieve

Maximum Specific Gravity

- **Loose (uncompacted) mixture**

$$G_{mm} = \frac{\text{Mass agg. and AC}}{\text{Vol. agg. and AC}}$$

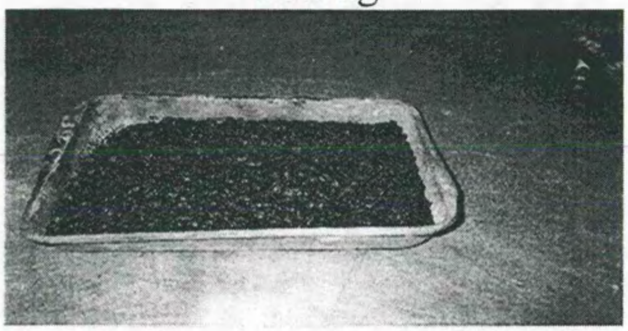
Testing

- **Mixing of asphalt and aggregate**
- **Mass in air**
- **Mass under water**

Rice Gravity (T209)

- **Sample Preparation**
  - Obtain appropriate sample size by splitting or quartering if not lab prepared (function of nominal maximum size)
  - Break lumps so fine aggregates pass 1/4" sieve (may require heating).

Testing



Loose Mix at Room Temperature

Rice Gravity (T209)

- **Flask Calibration**
  - Determine mass of water required to fill flask at 25±0.5°C and record mass to nearest 0.1g (**D**)

Test Procedure (T209)

- Cool sample to room temp, place in flask or bowl and record net mass to 0.1g (**A**)
- Apply partial vacuum of 30mm Hg or less absolute pressure for 15±1 minute
- Agitate while vacuuming - continuously (mechanical) or at 2 minute intervals (manual)
- Suspend bowl and contents in water at 25±1°C for 10±1 minute, record net mass to 0.1g (**C**)
- **OR** fill flask with water and bring to constant temp of 25±1°C in bath for 10±1 minute, record mass to 0.1g (**E**)

Calculations (T209)

- Bowl Determination: $G_{mm}=A/(A-C)$
- Flask Determination: $G_{mm}=A/(A+D-E)$
- Maximum Density = $G_{mm} \times \gamma_{water}$

- Report all gravities to 0.001

BULK SPECIFIC GRAVITY OF COMPACTED BITUMINOUS MIXTURES USING SATURATED SURFACE-DRY SPECIMENS

AASHTO T 166

Developed by
FHWA Multi-Regional Asphalt Training & Certification Group

December 11, 1998

NOTE

Successful completion of the following training materials, including examination and performance evaluation is a prerequisite for this training package.

- AASHTO T 168, Sampling Bituminous Paving Mixtures
- AASHTO TP 4, Method For Preparing and Determining the Density of Hot Mix Asphalt(HMA) Specimens by Means of a SHRP Gyratory Compactor.

TABLE OF CONTENT

Bulk Specific Gravity of Compacted Bituminous Mixtures Using Saturated Surface-dry Specimens

The compaction of Hot Mix Asphalt (HMA) both in the field and in the laboratory is an important characteristic to be determined for mixture quality control. The bulk specific gravity of compacted specimens can be determined on pavement cores or laboratory compacted specimens. The bulk specific gravity of compacted bituminous mixtures (G_{mb}), using a saturated surface-dry specimen, is used to determine air voids(P_a) and may be used for comparison between roadway compaction tests and laboratory compacted specimens.

The G_{mb} is determined by measuring the volume of the specimen by displacement when submerged in water. The dry mass and the saturated surface dry (SSD) mass after submerging in water are also measured.

The submerged mass is subtracted from the SSD mass to determine the volume of displaced water, which is the same as the volume of the specimen. Dividing the dry mass of the specimen by the volume of the specimen yields the G_{mb}.

Common Testing Errors

- Submerged specimen touches the side of the water container.
- Water temperature is not 25°±1°C (77°±1.8°F).
- Specimens with high voids (>10%) may absorb excess water. (Use AASHTO T 275)
- Dirty water used.
- Specimens not cooled to 25°±5°C (77°±9°F).

TEST METHODOLOGY

Apparatus

- Balance (accurate to 0.1 gram).
- Oven for heating specimen
- Submersion basket
- Container for water
- Damp towel

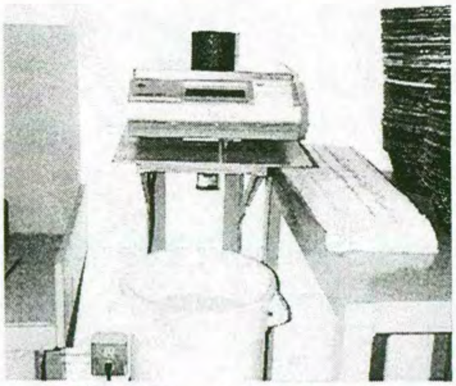
Sample Preparation

The sample should be secured according to AASHTO T 168. The mixture should then be prepared for testing using AASHTO TP 4, AASHTO T 245, or another suitable compaction method.

Testing Procedure

Once the specimen has been compacted using one of the above methods, it must be cooled to 25°∓5° (77°±9°F). Weigh the dry specimen and record the dry mass (A) to the nearest 0.1g.

Submerge the specimen in water that is at a temperature of 25°±1°C (77°±1.8°F) and suspend it from the scale being careful not to trap any air bubbles under the specimen. Record the submerged mass (C) to the nearest 0.1g after the specimen has stabilized in the water for 3 to 5 minutes.



Weighing specimen to Determine G_{mb}

Remove the specimen from the water and quickly blot the specimen surface dry. Weigh the specimen and record the SSD mass (B) to the nearest 0.1g.

Blotting Sample Dry

Calculations

Calculate the bulk specific gravity of the specimen as follows:

$$G_{mb} = \frac{A}{B - C}$$

where:

A = dry mass
B = SSD mass
C = submerged mass

Report bulk specific gravity to three decimal places.

Example

Given: Dry mass of the specimen (A) = 4799.0 g
SSD mass of the specimen (B) = 4801.0 g
Submerged mass of the specimen (C) = 2799.0 g

$$\frac{4799.0}{4801.0 - 2799.0} = 2.397$$

GLOSSARY

Specific gravity - the ratio of the mass in air of a volume of material to the mass in air of an equal volume of water.

Saturated surface dry - the condition of a material when it has absorbed as much water as it can and the outside of the material has no free water.

MAXIMUM SPECIFIC GRAVITY OF BITUMINOUS PAVING MIXTURES

AASHTO T 209

Multi-Regional Training and Certification

M-TRAC

FHWA SPONSORED

Developed by

December 11, 1998

NOTE

Successful completion of the following training materials, including examination and performance evaluation is a prerequisite for this training package.

- AASHTO T 168, Sampling Bituminous Paving Mixtures

TABLE OF CONTENT

Maximum Specific Gravity of Bituminous Paving Mixtures

The volumetric properties of Hot Mix Asphalt (HMA) must be controlled during design and production in order to produce durable pavements. James Rice invented a test to measure the volume of a mixture with all the air voids removed. The maximum specific gravity (G_{mm}) of a bituminous mixture is the ratio of the mass of the loose sample to the mass of an equal volume of water at the standard temperature of 25°C (77°F).

G_{mm} is used along with the bulk specific gravity (G_{mb}) of the compacted mixture to determine air voids (P_a). It is often used also for determining the percent of compaction in laboratory specimens or during roadway compaction.

This text will explain the flask method for determining the maximum specific gravity. The flask method is the preferred test method due to the lower variability of the method.

Common Testing Errors

- Not breaking up the sample completely.
- Not maintaining less than 28±2 mm absolute pressure which could be attributed to one of the following:
  a. Air bubble in mercury manometer
  b. Manometer not connected directly to pycnometer
  c. Clogged vacuum lines
  d. Moisture or foreign material getting into the vacuum pump
- Not agitating the sample enough.
- Air bubbles trapped in the pycnometer when the cover is placed on it.
- Temperatures of water not checked.
- Uncoated particles or particles that rupture under vacuum which absorb water.
- Overheating absorptive materials.

TEST METHODOLOGY - FLASK METHOD

Apparatus


Pycnometer and flask

- Pycnometer or flask
- Thermometer
- Mercury Manometer
- Vibrating Table (optional)
- Pycnometer top or cover glass
- Scale
- Vacuum pump, tubing and connectors

Sample Preparation
If the sample is not tested soon after it has been sampled, it will cool down and need to be reheated in the oven before the G_{mm} test can be run. If necessary, heat the sample only enough to soften it.
Reduce the sample to the proper size, if necessary, by quartering or other suitable means that will ensure a representative sample. See Table 1 below.

Maximum Aggregate Size	Minimum Sample Size
25.0 mm (1in.)	2500 g
19.0 mm (¾ in.)	2000 g
12.5 mm (½ in.)	1500 g
9.5 mm (⅜ in.)	1000 g
4.75 mm (#4)	500 g

Table 1

Separate the particles of coarse aggregate . Break up any clumps of fine aggregate so that no clump is larger than 6.5 mm (¼ in.). Stirring or spading the mixture as it cools will prevent clumps. If the clumps are difficult to break up, warming the mixture for a few minutes will be helpful.

Stirring Sample and Breading Clumps

Allow the mixture to cool to room temperature before proceeding with the test.

Calibration of Pycnometer

The flask or pycnometer is calibrated by filling the vessel with water. The water temperature needs to be 25°C (77°F). Place the cover or a glass cover plate on the vessel, being sure that no air bubbles are trapped. Dry the outside of the vessel, cover, and then weigh it. Record the mass to the nearest 0.1 gram. This is mass (D), the mass of the pycnometer filled with water at the test temperature. If temperatures other than 25°C (77°F) are encountered during testing, the vessel should be calibrated at a higher and a lower temperature. A calibration curve will then need to be developed for the pycnometer.

Procedure

Tare the pycnometer on a scale and add the sample. Record the mass of the sample to the nearest 0.1 gram. This mass is the dry sample in air (A).

Add enough water to completely cover the sample.

Connect the pycnometer to the vacuum system and remove the entrapped air. Maintain a vacuum, as measured by a mercury manometer, of 28±2 mm absolute pressure for 15±2 minutes. Continuous agitation is recommended to help release the air bubbles. This agitation can best be completed with the use of a vibrating table. If continuous agitation is not possible, rock or shake the pycnometer at approximately 2 minute intervals for the duration of the air removal.
After the 15 minute vacuum period is complete, slowly release the vacuum and allow the pycnometer and sample to sit for 10±1 minute.

The pycnometer may be placed in a 25°C (77°F) water bath for the ten minutes or water of the proper temperature may be added to fill the pycnometer. If a water bath is not used, the temperature of the water in the pycnometer needs to be adjusted to 25°±1°C (77°±1.8°F).

If it is not possible to maintain the proper temperature, correction factors for the change in density of the water and the asphalt cement must be used in conjunction with a calibration curve for the pycnometer.

Place the top or cover glass on the pycnometer, being sure that there are no air bubbles trapped inside. Dry the outside of the pycnometer. Weigh the pycnometer and record the mass to the nearest 0.1 gram. This is the mass of the pycnometer filled with the sample and water at the test temperature (E).

Sample Being Tested

Calculations

Maximum Specific Gravity (G_{mm}) = $$\frac{A}{A+D-E}$$

where: **A = Mass of dry sample in air**
D = Mass of pycnometer filled with water at test temperature
E = Mass of pycnometer filled with the sample and water at test temperature

Report Maximum Specific Gravity (G_{mm}) to three decimal places.

Example

Given: Mass of dry sample in air (A) = 2020.0 g
Mass of pycnometer filled with water at test temperature (D) = 7800.0 g

Mass of pycnometer filled with sample and water at test temperature (E) =9000.0 g

$$\frac{2020.0}{2020.0 + 7800.0 - 9000.0} = 2.463$$

GLOSSARY

Specific gravity	-	**the ratio of the mass in air of a volume of material to the mass in air of an equal volume of water.**
Pycnometer	-	**a vessel of known volume used to measure the volume of a material placed in it by determining how much water is displaced.**
Mercury Manometer	-	**a tube sealed at one end and filled with mercury, which, when subjected to a vacuum, will register a comparison between the applied vacuum and the nearly total vacuum that exists in the sealed end. The degree of vacuum is expressed as absolute pressure or residual pressure, in mm. Smaller numbers (less pressure) indicate more vacuum.**

Transportation Center Materials Lab ACC Core Correlation Report

Project No.: NHS-6-3(41)--12-77
Contract ID: 77-0006-41
County: POLK

Contractor: QUALITY ASPHALT INC.
Mix Type: 3/4" TYPE A SURFACE
Mix Design No.: ABD8-1007

Date Placed: 10/20/98 Date Tested: 10/21/98 Plant Report No.: FC10-20 (1-7)

Core No.	W1 Dry	W2 Water	W3 Wet	Diff.	TC Lab Field Density	Road Field Density	Correlation Difference	Core Thickness
1	1,164.3	645.0	1,164.3	519.3	2.242	2.247	0.005	47
2	1,132.2	618.8	1,133.9	515.1	2.198	2.200	0.002	45
3	978.7	542.1	979.5	437.4	2.238	2.235	0.003	38
4	1,091.5	606.6	1,092.0	485.4	2.249	2.251	0.002	43
5	995.6	549.9	996.1	446.2	2.231	2.236	0.005	39
6	1,006.0	550.7	1,001.4	450.7	2.232	2.239	0.007	39
7	944.7	526.4	945.1	418.7	2.256	2.256	0.000	38

Remarks:

Date Placed: 10/26/98 Date Tested: 10/27/98 Plant Report No.: FC10-26 (1-7)

Core No.	W1 Dry	W2 Water	W3 Wet	Diff.	TC Lab Field Density	Road Field Density	Correlation Difference	Core Thickness
1	1,312.5	727.5	1,313.5	586.0	2.240	2.241	0.001	42
2	2,344.0	1,336.0	2,345.0	1,009.0	2.323	2.322	0.001	49
3	2,545.0	1,443.0	2,546.0	1,103.0	2.307	2.307	0.000	41
4	1,258.0	713.0	1,259.0	546.0	2.304	2.306	0.002	47
5	1,419.5	795.0	1,420.0	625.0	2.271	2.270	0.001	44
6	1,393.0	772.0	1,394.5	622.5	2.238	2.251	0.013	43
7	1,398.0	766.0	1,400.0	634.0	2.205	2.211	0.006	42

Remarks:

Date Placed: Date Tested: Plant Report No.:

Core No.	W1 Dry	W2 Water	W3 Wet	W3 - W2 Diff.	TC Lab Field Density	Road Field Density	Correlation Difference	Core Thickness
1					0.000			
2					0.000			
3					0.000			
4					0.000			
5					0.000			
6					0.000			
7					0.000			

Remarks:

CITC LAB
Transportation Center Laboratory

DAILY PLANT PAGE AND PLANT BOOK

The daily record of what is happening on your project goes on the Daily ACC Plant Page. This is where your information about the mix, gradations, cores, and the plant are brought together. This report is seen by the District Materials Engineer, the Resident Engineer, and the Central Offices to keep them aware of what is happening on a daily basis.

This report must be faxed to the District Materials Office within four hours after the start-up of the plant on the next working day. Hard copies of the report are to be mailed to the Project Engineer at the end of the project.

The plant report must be on a computer-generated form.

Instructions for completing this are in I.M. 508.

Todays Date:	06/18/01
Report No.:	1
Expected Tons Produced For The Day:	3,800
Mix Design Number:	ABD8-1007
Gradation Spec. 1 in. (25 mm) sieve:	100
Gradation Spec. 3/4 in. (19 mm) sieve:	90-100
Gradation Spec. 1/2 in. (12.5 mm) sieve:	83-90
Gradation Spec. 3/8 in. (9.5 mm) sieve:	76-90
Gradation Spec. #4 (4.75 mm) sieve:	43-57
Gradation Spec. #8 (2.36 mm) sieve:	23-35
Gradation Spec. #30 (600 um) sieve:	7-15
Gradation Spec. #200 (75 um) sieve:	2.0-5.3
% RAP in mix:	NA
Intended Added % Binder:	5.40
Intended Total % Binder:	5.40
% Aggregate No. 1 in Mix:	40.0
% Aggregate No. 2 in Mix:	32.0
% Aggregate No. 3 in Mix:	23.0
% Aggregate No. 4 in Mix:	5.0
% Aggregate No. 5 in Mix:	
% Aggregate No. 6 in Mix:	
% Aggregate No. 7 in Mix:	
% Aggregate No. 8 in Mix:	
Aggregate No. 1 Type & Source:	3/4" cr. Lmst. A35002
Aggregate No. 2 Type & Source:	3/8" chips A42002
Aggregate No. 3 Type & Source:	man. Sand A17008
Aggregate No. 4 Type & Source:	sand A35512
Aggregate No. 5 Type & Source:	
Aggregate No. 6 Type & Source:	
Aggregate No. 7 Type & Source:	
Aggregate No. 8 Type & Source:	
Cold Feed Sampled By:	Ray Johnson
Cold Feed Tested By:	Ray Johnson
Cold Feed Sampling Location:	stream flow
Project No.:	NHS-6-3(41)
Contract ID:	77-0006-41
County:	POLK
Contractor:	Quality Asphalt, Inc.
Mix Class:	
Mix Type:	HMA 30M ESAL
Mix Size:	3/4"
Course Placed:	Surface
Lab Voids Specifications:	3.5-5.0
Filler Bitumen Ratio Specifications:	0.6-1.4
Gsb From 956:	2.577
VMA at Recommended %Binder from 956:	13.04
Certified Technician's Name:	Ray Johnson
Certification No.:	C1213
Certified Technician's Name:	John Rayson
Certification No.:	C1312
% Binder in the RAP:	
RAP Source:	
RAP Gradation 1 1/2 in. (37.5 mm) Sieve:	
RAP Gradation 1 in. (25 mm) Sieve:	
RAP Gradation 3/4 in. (19 mm) Sieve:	
RAP Gradation 1/2 in. (12.5 mm) Sieve:	
RAP Gradation 3/8 in. (9.5 mm) Sieve:	
RAP Gradation #4 (4.75 mm) Sieve:	
RAP Gradation #8 (2.36 mm) Sieve:	
RAP Gradation #16 (1.18 mm) Sieve:	
RAP Gradation #30 (600 um) Sieve:	
RAP Gradation #50 (300 um) Sieve:	
RAP Gradation #100 (150 um) Sieve:	
RAP Gradation #200 (75 um) Sieve:	

DESIRED UNITS	
English	Metric
x	

"X" One Box Each

TYPE OF MIX	
Gyratory	Marshall
x	

N-design	Marshall Blows
109	

Gyratory Correction Factor

Expected Tons Produced For The Day:	3,800.00			
First Hot Box Sample Tons:	373.00	--	500.00	First Sublot = (tons)
Second Hot Box Sample Tons:	563.00	--	1,100.00	Second Sublot = (tons)
Third Hot Box Sample Tons:	2,127.00	--	1,100.00	Third Sublot = (tons)
Fourth Hot Box Sample Tons:	3,656.00	--	1,100.00	Fourth Sublot = (tons)

Daily Tank Stick For Virgin Binder Content

Tank No.:	1	2	3	4
Starting Time:	6:00 AM			
Tank Capacity (Gallons):	20,000			
Outage (% of Diameter):	89.2			
Direct Reading (Gallons):				
Beginning Temp. °F:	284			
Beginning Corrected Gallons:	1,077			
Total Pounds Binder Added During Day:	487,954			
Pounds/Gallon:	8.5300			
Added Corrected Gallons:	57,204			
Ending Time:	7:30 PM			
Outage (% of Diameter):	62.4			
Direct Reading (Gallons):				
Ending Temp. °F:	293			
Ending Corrected Gallons:	6,332			
Total Pounds Of Binder Used:	443,125			
Total Pounds Of Mix Made:	8,391,190			
Total Pounds Of Mix Wasted:	2,205			
Net Tons Of Binder Used On Road =	**221.50**			
Net Tons Of Mix Used On Road =	**4,194.49**			
Percent Virgin Binder By Tank Stick =	**5.28**			

Asphalt Sp. Gr. (Gb)
1.0240
Total Pounds Of Binder Used By Flow Meter or Batch Totals

Lab. No.:	graD 1-B
Orig. Dry Mass:	2,544.4
Dry Mass Washed:	2,459.3
Total Minus #4 (W1):	
Reduced Minus #4 (W2):	
Conversion Factor:	

Only use green colored cells when (Using Box & 203mm Sieves).

Sieve Size	Reduced Minus #4	Total or Calc Mass Retd.	% Retd.	% Passing	Reported Final	Composite % Psg.	Reported Final	Specs.
1 1/2 in.				100.0	100			
1 in.				100.0	100			100
3/4 in.		12.5	0.5	99.5	100			90-100
1/2 in.		266.6	10.5	89.0	89			83-90
3/8 in.		311.4	12.2	76.8	77			76-90
#4		725.4	28.6	48.2	48			43-57
#8		466.5	18.3	29.9	30			23-35
#16		282.5	11.1	18.8	19			
#30		168.4	6.6	12.2	12			7-15
#50		125.5	4.9	7.3	7.3			
#100		66.9	2.6	4.7	4.7			
#200		28.4	1.1	3.6	3.6			2.0-5.3
Pan		5.5	3.6					
Wash		85.1						
Totals		2,544.7	100.0					
Tolerances		100.0						

Density Record

Core No.:	1	2	3	4	5	6	7
Station	110+66	144+35	166+81	198+45	212+16	238+77	254+75
CL Reference	1.0 RT	6.0 LT	2.8 LT	1.9 RT	2.8 LT	8.0 RT	2.8 RT
W 1 Dry	1,205.5	1,236.6	1,388.5	1,279.4	1,145.5	1,401.0	1,215.8
W 2 in H20	685.9	701.6	799.6	736.1	648.2	795.5	696.1
W 3 Wet	1,206.6	1,238.1	1,389.6	1,280.9	1,147.0	1,402.5	1,217.1
Thickness (in.)	1 5/8	1 3/4	2	1 3/4	1 1/2	2	1 3/4

Date Tested: 06/19/98

Tested By: John Rayson

Required Density: 95.0

Information Only							
% Density	97.638	97.216	99.241	99.030	96.879	97.343	98.439
% Voids	6.5	6.9	5.0	5.2	7.2	6.8	5.7

Temperatures

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

800241 - 07/00 ver. 1.1

DAILY HMA PLANT REPORT

Project No.: NHS-6-3(41)
Contract ID: 77-0006-41
Mix Design No.: ABD8-1007

Contractor: Quality Asphalt, Inc.
County: POLK
Recycle Source:

Class:
Size: 3/4"
Mix Type: HMA 30M ESAL

Report No.: 1
Design Blows:
Design Gyrations: 109

Hot Box I.D. No.:		SU6-18A	SU6-18B	SU6-18C	SU6-18D	
Date Sampled:		06/18/01	06/18/01	06/18/01	06/18/01	
Gradation ID:	Specs	grad 1-A	graD 1-B			
1 in. (25mm) Sieve	100	100	100			
3/4 in. (19mm) Sieve	90-100	99	100			
1/2 in. (12.5mm) Sieve	83-90	89	89			
3/8 in. (9.5mm) Sieve	76-90	76	77			
* #4 (4.75mm) Sieve	43-57	47	48			
* Moving Average						
* #8 (2.36mm) Sieve	23-35	29	30			
* Moving Average						
#16 (1.18mm) Sieve		19	19			
* #30 (600um) Sieve	7-15	13	12			
* Moving Average						
#50 (300um) Sieve		7.6	7.3			
#100 (150um) Sieve		5.4	4.7			
* #200 (75um) Sieve	2.0-5.3	4.2	3.6			
* Moving Average						
Compliance (Y/N)		y	y			
Intended Added, % Binder	5.40					
Actual Added, % Binder		5.28				
Intended Total, % Binder	5.40					
Actual Total, % Binder		5.28				
Gmb:		2.373	2.365	2.375	2.371	
Gmm:		2.469	2.477	2.480	2.478	
Pa:		3.9	4.5	4.2	4.3	
Moving Average	3.5-5.0				**4.2**	
Time		7:05 AM	8:35 AM	1:30 PM	4:55 PM	This
Station		112+55	134+22	189+98	244+55	Column
Side		WB	WB	WB	WB	Is For
Sample Tons		373.00	563.00	2,127.00	3,656.00	Dist. Lab
Sublot Tons		500.00	1,100.00	1,100.00	1,494.49	Test
Tons to Date						Results
Fines / Bitumen Ratio	0.6-1.4	1.13				

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

Date Placed: 06/18/01 Date Tested: 06/19/01

Course Placed: Surface Tested By: John Rayson

Density Record

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

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

Q.I. = (2.323 -- 2.252) / 0.022 = **3.21**

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

Film Thickness (FT): **9.2** VMA: **12.9** D.O.T. Results Used:

Remarks: grad 1-B random gradation. VMA below min. spec. 13.0 but is within plus or minus 1% of JMF target of 13.04, voids and film thickness comply

Gsb: 2.577 Gb: 1.0240 Effective % Binder: 3.71

Mix Change Information:

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

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

Film Thickness & VMA

Sieve Analysis % Passing													
Sieve	1 1/2	1	3/4	1/2	3/8	#4	#8	#16	#30	#50	#100	#200	
Gradation	100	100	99	89	76	47	29	19	13	7.6	5.4	4.2	
Surface Area Coefficient						0.0041	0.0082	0.0164	0.0287	0.0614	0.1229	0.3277	Total
Surface Area m2 / kilogram					+0.41	0.19	0.24	0.31	0.37	0.47	0.66	1.38	4.03
													SA

Pb= 5.28 % — Actual Total, % Binder

Gb= 1.0240 — From Asphalt Supplier

Gsb= 2.577 — From Mix Design Information

Gmm= 2.476 — From Daily Test Data

Aggregate Effective Sp. Gr. =

$$\frac{100.0 - 5.28}{(100.0 \;/\; 2.476) - (5.28 \;/\; 1.0240)} = \underline{2.689}\ \text{Gse}$$

Percent Absorbed Binder =

$$\frac{100.0 \quad (2.689 - 2.577) \quad 1.0240}{(2.689) \quad (2.577)} = \underline{1.66}\ \%\ \text{Pba}$$

Effective % Binder Content =

$$5.28 - \frac{(1.66) \quad (94.72)}{100.0} = \underline{3.71}\ \%\ \text{Pbe}$$

Film Thickness =

$$\frac{3.71 \quad X \quad 10}{(4.03)} = \underline{9.2}\ \text{microns}$$

VMA = 100 - ((2.371 X 94.72) / 2.577)) = 12.9 %

Todays Date:	06/19/01
Report No.:	2
Expected Tons Produced For The Day:	4,000
Mix Design Number:	ABD8-1007
Gradation Spec. 1 in. (25 mm) sieve:	100
Gradation Spec. 3/4 in. (19 mm) sieve:	90-100
Gradation Spec. 1/2 in. (12.5 mm) sieve:	83-90
Gradation Spec. 3/8 in. (9.5 mm) sieve:	76-90
Gradation Spec. #4 (4.75 mm) sieve:	43-57
Gradation Spec. #8 (2.36 mm) sieve:	23-35
Gradation Spec. #30 (600 um) sieve:	7-15
Gradation Spec. #200 (75 um) sieve:	2.0-5.3
% RAP in mix:	NA
Intended Added % Binder:	5.40
Intended Total % Binder:	5.40
% Aggregate No. 1 in Mix:	40.0
% Aggregate No. 2 in Mix:	32.0
% Aggregate No. 3 in Mix:	23.0
% Aggregate No. 4 in Mix:	5.0
% Aggregate No. 5 in Mix:	
% Aggregate No. 6 in Mix:	
% Aggregate No. 7 in Mix:	
% Aggregate No. 8 in Mix:	
Aggregate No. 1 Type & Source:	3/4" cr. Lmst. A35002
Aggregate No. 2 Type & Source:	3/8" chips A42002
Aggregate No. 3 Type & Source:	man. Sand A17008
Aggregate No. 4 Type & Source:	sand A35512
Aggregate No. 5 Type & Source:	
Aggregate No. 6 Type & Source:	
Aggregate No. 7 Type & Source:	
Aggregate No. 8 Type & Source:	
Cold Feed Sampled By:	Ray Johnson
Cold Feed Tested By:	Ray Johnson
Cold Feed Sampling Location:	stream flow
Project No.:	NHS-6-3(41)--12-77
Contract ID:	77-0006-41
County:	POLK
Contractor:	Quality Asphalt, Inc.
Mix Class:	
Mix Type:	HMA 30M ESAL
Mix Size:	3/4"
Course Placed:	Surface
Lab Voids Specifications:	3.5-5.0
Filler Bitumen Ratio Specifications:	0.6-1.4
Gsb From 956:	2.577
VMA at Recommended %Binder from 956:	13.04
Certified Technician's Name:	Ray Johnson
Certification No.:	C1213
Certified Technician's Name:	John Rayson
Certification No.:	C1312
% Binder in the RAP:	
RAP Source:	
RAP Gradation 1 1/2 in. (37.5 mm) Sieve:	
RAP Gradation 1 in. (25 mm) Sieve:	
RAP Gradation 3/4 in. (19 mm) Sieve:	
RAP Gradation 1/2 in. (12.5 mm) Sieve:	
RAP Gradation 3/8 in. (9.5 mm) Sieve:	
RAP Gradation #4 (4.75 mm) Sieve:	
RAP Gradation #8 (2.36 mm) Sieve:	
RAP Gradation #16 (1.18 mm) Sieve:	
RAP Gradation #30 (600 um) Sieve:	
RAP Gradation #50 (300 um) Sieve:	
RAP Gradation #100 (150 um) Sieve:	
RAP Gradation #200 (75 um) Sieve:	

DESIRED UNITS	
English	Metric
x	

"X" One Box Each

TYPE OF MIX	
Gyratory	Marshall
x	

N-design	Marshall Blows
109	

Gyratory Correction Factor

Expected Tons Produced For The Day:	4,000.00			
First Hot Box Sample Tons:	346.00	--	500.00	First Sublot = (tons)
Second Hot Box Sample Tons:	845.00	--	1,166.67	Second Sublot = (tons)
Third Hot Box Sample Tons:	1,852.00	--	1,166.67	Third Sublot = (tons)
Fourth Hot Box Sample Tons:	3,787.00	--	1,166.67	Fourth Sublot = (tons)

Daily Tank Stick For Virgin Binder Content

Tank No.:	1	2	3	4
Starting Time:	6:00 a.m.			
Tank Capacity (Gallons):	20,000			
Outage (% of Diameter):	16.4			
Direct Reading (Gallons):				
Beginning Temp. °F:	293			
Beginning Corrected Gallons:	16,449			
Total Pounds Binder Added During Day:	497,500			
Pounds/Gallon:	8.5300			
Added Corrected Gallons:	58,324			
Ending Time:	7:45 p.m.			
Outage (% of Diameter):	4.2			
Direct Reading (Gallons):				
Ending Temp. °F:	293			
Ending Corrected Gallons:	18,154			
Total Pounds Of Binder Used:	482,960			
Total Pounds Of Mix Made:	8,874,925			
Total Pounds Of Mix Wasted:	1,200			
Net Tons Of Binder Used On Road =	**241.45**			
Net Tons Of Mix Used On Road =	**4,436.86**			
Percent Virgin Binder By Tank Stick =	**5.44**			

Asphalt Sp. Gr. (Gb)
1.0240
Total Pounds Of Binder Used By Flow Meter or Batch Totals

Gmb - Test Data	Test 1	Test 1	Test 1	Test 2	Test 2	Test 2	Test 3	Test 3	Test 3	Test 4	Test 4	Test 4
Hot Box ID Number:	SU6-19A			SU6-19B			SU6-19C			SU6-19D		
Hot Box Sample Tons:	346			845			1,852			3,787		
Time:	7:30 a.m.			9:15 a.m.			12:35 p.m.			5:00 p.m.		
Station:	266+66			296+55			333+33			366+66		
Side:	WB			WB			WB			WB		
Compaction Temp. °F:	275			275			275			275		
Specimen ID No.:	2-1A	2-1B		2-2A	2-2B		2-3A	2-3B		2-4A	2-4B	
Design No. of Gyrations:	109	109		109	109		109	109		109	109	
Mass In Air:	4,798.0	4,797.7		4,796.6	4,798.5		4,799.1	4,798.3		4,797.7	4,796.6	
Mass In Water:	2,825.0	2,821.2		2,820.3	2,823.3		2,826.3	2,825.9		2,820.4	2,821.0	
Mass SSD:	4,800.0	4,799.2		4,799.1	4,800.6		4,801.5	4,800.7		4,799.5	4,798.8	
Gyratory Height @ N Initial:	133.6	133.5		133.9	132.8		134.1	133.8		134.2	134.1	
Gyratory Height @ N Design:	117.0	117.5		116.6	116.2		116.7	116.5		117.0	116.9	
Gyratory Height @ N Max (Optional):	114.9	115.1		114.4	114.1		115.6	115.3		115.1	115.0	
Measured Density :	2.429	2.426		2.424	2.427		2.430	2.430		2.424	2.425	
Calculated Density N Design:	2.321	2.311		2.328	2.337		2.327	2.331		2.320	2.322	
Corrected Density N Design:	2.386	2.377		2.378	2.383		2.407	2.405		2.384	2.386	
Avg. Corrected Gyratory Density (Gmb):		2.382			2.381			2.406			2.385	
Gmm - Test Data												
Pycnometer No.:		1			1			1			1	
Mass; Container & Sample:		2,020.5			2,022.5			2,020.0			2,020.9	
Mass; Container:												
"W", Sample Mass:		2,020.5			2,022.5			2,020.0			2,020.9	
"W1", Mass Pyc. & H2O @ Test Temp.:		7,229.5			7,229.5			7,229.5			7,229.5	
Total Mass:		9,250.0			9,252.0			9,249.5			9,250.4	
"W2", Mass Pyc. & Water & Sample:		8,432.2			8,435.0			8,436.2			8,434.0	
Mass Displaced Water:		817.8			817.0			813.3			816.4	
Test Temperature Of Water (°F):		77			77			77			77	
R Multiplier (chart):		1.0000			1.0000			1.0000			1.0000	
(Gmm):		2.471			2.476			2.484			2.475	
Pa - Test Data:		3.6			3.8			3.1			3.6	
Gyratory Slope:	11.150	11.635		10.790	11.150		10.619	10.704		10.878	10.790	
Average Slope:		11.39			10.97			10.66			10.83	
% Gmm @ N Ini. & N Max.:	84.60	98.24		83.93	97.96		84.32	97.83		84.02	97.96	

Lab. No.:	grad 2-A
Orig. Dry Mass:	2,558.3
Dry Mass Washed:	2,450.1
Total Minus #4 (W1):	
Reduced Minus #4 (W2):	
Conversion Factor:	

Only use green colored cells when (Using Box & 8 in. Sieves).

Sieve Size	Reduced Minus #4	Total or Calc Mass Retd.	% Retd.	% Passing	Reported Final	Composite % Psg.	Reported Final	Specs.
1 1/2 in.				100.0	100			
1 in.				100.0	100			100
3/4 in.		15.4	0.6	99.4	99			90-100
1/2 in.		275.6	10.8	88.6	89			83-90
3/8 in.		325.5	12.7	75.9	76			76-90
#4		740.0	28.8	47.1	47			43-57
#8		456.0	17.8	29.3	29			23-35
#16		255.4	10.0	19.3	19			
#30		163.3	6.4	12.9	13			7-15
#50		130.5	5.1	7.8	7.8			
#100		55.7	2.2	5.6	5.6			
#200		30.5	1.2	4.4	4.4			2.0-5.3
Pan		3.3	4.4					
Wash		108.2						
Totals		2,559.4	100.0					
Tolerances		100.0						

Lab. No.:	grad 2-B
Orig. Dry Mass:	2,559.9
Dry Mass Washed:	2,451.1
Total Minus #4 (W1):	
Reduced Minus #4 (W2):	
Conversion Factor:	

Only use green colored cells when (Using Box & 203mm Sieves).

Sieve Size	Reduced Minus #4	Total or Calc Mass Retd.	% Retd.	% Passing	Reported Final	Composite % Psg.	Reported Final	Specs.
1 1/2 in.				100.0	100			
1 in.				100.0	100			100
3/4 in.		12.5	0.5	99.5	100			90-100
1/2 in.		266.6	10.4	89.1	89			83-90
3/8 in.		311.4	12.1	77.0	77			76-90
#4		725.4	28.2	48.8	49			43-57
#8		466.5	18.1	30.7	31			23-35
#16		282.5	11.0	19.7	20			
#30		168.4	6.6	13.1	13			7-15
#50		125.5	4.9	8.2	8.2			
#100		66.9	2.6	5.6	5.6			
#200		28.4	1.1	4.5	4.5			2.0-5.3
Pan		5.5	4.5					
Wash		108.8						
Totals		2,568.4	100.0					
Tolerances		100.3						

Density Record

Core No.:	1	2	3	4	5	6	7
Station	261+21	287+55	299+10	324+15	335+05	355+00	374+12
CL Reference	1.0 LT	1.9 RT	2.9 RT	1.9 LT	1.0 LT	2.9 LT	1.0 RT
W 1 Dry	1,212.2	1,240.0	1,390.5	1,285.1	1,155.2	1,412.3	1,221.8
W 2 in H20	689.9	700.0	800.2	738.5	645.8	799.9	703.6
W 3 Wet	1,213.5	1,242.0	1,392.1	1,287.5	1,157.7	1,414.1	1,223.2
Thickness (in.)	1 3/4	1 3/4	2	1 3/4	1 5/8	2	1 3/4

Date Tested: 06/20/01

Tested By: John Rayson

Required Density: 95.0

Information Only							
% Density	96.902	95.772	98.326	97.991	94.475	96.233	98.409
% Voids	6.5	7.6	5.2	5.5	8.9	7.2	5.1

Temperatures

Time	7:00	9:00	11:00	1:00	3:00	5:00	7:00
Air Temp. °F	60	65	70	72	73	75	72
Binder Temp. °F	295	300	302	305	302	300	298
Mix Temp. °F	297	302	310	305	302	300	301

800241 - 07/00 ver. 1.1

DAILY HMA PLANT REPORT

Project No.: NHS-6-3(41)--12-77
Contract ID: 77-0006-41
Mix Design No.: ABD8-1007

Contractor: Quality Asphalt, Inc.
County: POLK
Recycle Source:

Class:
Size: 3/4"
Mix Type: HMA 30M ESAL

Report No.: 2
Design Blows:
Design Gyrations: 109

Hot Box I.D. No.:		SU6-19A	SU6-19B	SU6-19C	SU6-19D	TC Lab
Date Sampled:		06/19/01	06/19/01	06/19/01	06/19/01	6/19/01
Gradation ID:	Specs	grad 2-A	grad 2-B		Avg.	grad 2-A
1 in. (25mm) Sieve	100	100	100		100	100
3/4 in. (19mm) Sieve	90-100	99	100		100	98
1/2 in. (12.5mm) Sieve	83-90	89	89		89	87
3/8 in. (9.5mm) Sieve	76-90	76	77		77	75
* #4 (4.75mm) Sieve	43-57	47	49		48	45
* Moving Average						
* #8 (2.36mm) Sieve	23-35	29	31		30	28
* Moving Average						
#16 (1.18mm) Sieve		19	20		20	18
* #30 (600um) Sieve	7-15	13	13		13	12
* Moving Average						
#50 (300um) Sieve		7.8	8.2		8	7.5
#100 (150um) Sieve		5.6	5.6		5.6	5.5
* #200 (75um) Sieve	2.0-5.3	4.4	4.5		4.5	4.5
* Moving Average						
Compliance (Y/N)		y	y		2	
Intended Added, % Binder	5.40					
Actual Added, % Binder		5.44			5.44	5.44
Intended Total, % Binder	5.40					
Actual Total, % Binder		5.44			5.44	5.44
Gmb:		2.382	2.381	2.406	2.385	2.396
Gmm:		2.471	2.476	2.484	2.475	2.480
Pa:		3.6	3.8	3.1	3.6	3.4
Moving Average	3.5-5.0	**4.2**	**4.0**	**3.7**	**3.5**	SU6-19A
Time		7:30 a.m.	9:15 a.m.	12:35 p.m.	5:00 p.m.	This
Station		266+66	296+55	333+33	366+66	Column
Side		WB	WB	WB	WB	Is For
Sample Tons		346.00	845.00	1,852.00	3,787.00	Dist. Lab
Sublot Tons		500.00	1,166.67	1,166.67	1,603.52	Test
Tons to Date					7,829.71	Results
Fines / Bitumen Ratio	0.6-1.4	1.17			1.19	1.19

Gsb: 2.577 Gb: 1.0240 Effective % Binder: 3.77

Time	7:00	9:00	11:00	1:00	3:00	5:00	7:00
Air Temp. °F	60	65	70	72	73	75	72
A.C. Temp. °F	295	300	302	305	302	300	298
Mix Temp. °F	297	302	310	305	302	300	301

Date Placed: 06/19/01 Date Tested: 06/20/01

Course Placed: Surface Tested By: John Rayson

Density Record

Core No.:	1	2	3	4	5	6	7
Station	261+21	287+55	299+10	324+15	335+05	355+00	374+12
CL Reference	1.0 LT	1.9 RT	2.9 RT	1.9 LT	1.0 LT	2.9 LT	1.0 RT
W 1 Dry	1,212.2	1,240.0	1,390.5	1,285.1	1,155.2	1,412.3	1,221.8
W 2 in H20	689.9	700.0	800.2	738.5	645.8	799.9	703.6
W 3 Wet	1,213.5	1,242.0	1,392.1	1,287.5	1,157.7	1,414.1	1,223.2
Difference	523.6	542.0	591.9	549.0	511.9	614.2	519.6
Field Density	2.315	2.288	2.349	2.341	2.257	2.299	2.351
% Density	96.902	95.772	98.326	97.991	94.475	96.233	98.409
% Voids	6.5	7.6	5.2	5.5	8.9	7.2	5.1
Thickness (in.)	1 3/4	1 3/4	2	1 3/4	1 5/8	2	1 3/4

5-16

Gmb (Lot Avg.): **2.389** Avg. Field Density: **2.314**

Gmm (Lot Avg.): **2.477** Avg. % Density: **96.873**

Dist. Labs Pa: Avg. % Field Voids: **6.6**

Target % RAP: **NA** Specified % Density: 95

Q.I. = (2.314 -- 2.270) / 0.035 = **1.27**

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

Film Thickness (FT): **9.0** VMA: **12.3** D.O.T. Results Used:

Remarks: Gradation and hot box correlation - OK

Mix Change Information: Aggr. Interchange will be made before start-up tomorrow new proportions 35-27-23-5 to increase voids and VMA

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

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

Film Thickness & VMA

Sieve Analysis % Passing													
Sieve	1 1/2	1	3/4	1/2	3/8	#4	#8	#16	#30	#50	#100	#200	
Gradation	100	100	100	89	77	48	30	20	13	8	5.6	4.5	
Surface Area Coefficient						0.0041	0.0082	0.0164	0.0287	0.0614	0.1229	0.3277	Total
Surface Area m2 / kilogram					+0.41	0.20	0.25	0.33	0.37	0.49	0.69	1.47	4.21
													SA

Pb=	5.44 %	Actual Total, % Binder
Gb=	1.0240	From Asphalt Supplier
Gsb=	2.577	From Mix Design Information
Gmm=	2.477	From Daily Test Data

Aggregate Effective Sp. Gr. =

$$\frac{100.0 - 5.44}{(100.0 / 2.477) - (5.44 / 1.0240)} = \underline{2.697}\ \text{Gse}$$

Percent Absorbed Binder =

$$\frac{100.0\ (2.697 - 2.577)\ 1.0240}{(2.697)\ (2.577)} = \underline{1.77}\ \%\ \text{Pba}$$

Effective % Binder Content =

$$5.44 - \frac{(1.77)\ (94.56)}{100.0} = \underline{3.77}\ \%\ \text{Pbe}$$

Film Thickness =

$$\frac{3.77 \times 10}{(4.21)} = \underline{9.0}\ \text{microns}$$

VMA =

$$100 - ((2.389 \times 94.56) / 2.577)) = \underline{12.3}\ \%$$

Daily Diary

Sunrise:	06:21			
Sunset:	20:37			
Low:	59 (°F)	**High:**	75	(°F)
Weather:	partly cloudy - calm			

Plant shut down from 1:30 to 2:10 silo full working on intersections

began hauling in 3/4" cr. Lmst. At 10:00 adding to stockpile

Daily Production Summary

Type	Course		
HMA 30M ESAL	Surface	Tons of Mix Produced:	4,437.46
		Tons of Binder Produced:	241.48
		Tons Wasted:	0.60

	Type or Source	%	
Tons Of RAP In Mix Produced:		NA	
Tons Of Agg 1 In Mix Produced:	3/4" cr. Lmst. A35002	40.0	1,678.15
Tons Of Agg 2 In Mix Produced:	3/8" chips A42002	32.0	1,342.52
Tons Of Agg 3 In Mix Produced:	man. Sand A17008	23.0	964.94
Tons Of Agg 4 In Mix Produced:	sand A35512	5.0	209.77
Tons Of Agg 5 In Mix Produced:			
Tons Of Agg 6 In Mix Produced:			
Tons Of Agg 7 In Mix Produced:			
Tons Of Agg 8 In Mix Produced:			

Determination Of Asphalt Binder Content By (Gmm)

Total % Binder (Pb):	5.28	
Asphalt Specific Gravity (Gb) @ 77 °F:	1.0240	
Maximum Sp. Gr. (Gmm):	2.477	sample 1
Maximum Sp. Gr. (Gmm):	2.480	sample 2
Maximum Sp. Gr. (Gmm):	2.478	sample 3
Maximum Sp. Gr. (Gmm) individual test	2.475	sample to be analyzed
% Asphalt Binder by Calculation (Pb):	**5.40**	

Todays Date:	09/15/01
Report No.:	36
Expected Mg's. Produced For The Day:	2,177
Mix Design Number:	1BD9-016
Gradation Spec. 1 in. (25 mm) sieve:	100
Gradation Spec. 3/4 in. (19 mm) sieve:	93-100
Gradation Spec. 1/2 in. (12.5 mm) sieve:	80-90
Gradation Spec. 3/8 in. (9.5 mm) sieve:	67-81
Gradation Spec. #4 (4.75 mm) sieve:	48-62
Gradation Spec. #8 (2.36 mm) sieve:	38-49
Gradation Spec. #30 (600 um) sieve:	14-24
Gradation Spec. #200 (75 um) sieve:	2.0-6.1
% RAP in mix:	36.0
Intended Added % Binder:	3.90
Intended Total % Binder:	5.52
% Aggregate No. 1 in Mix:	27.0
% Aggregate No. 2 in Mix:	
% Aggregate No. 3 in Mix:	
% Aggregate No. 4 in Mix:	9.0
% Aggregate No. 5 in Mix:	28.0
% Aggregate No. 6 in Mix:	
% Aggregate No. 7 in Mix:	
% Aggregate No. 8 in Mix:	
Aggregate No. 1 Type & Source:	19 mm CL CHIP EC A85006
Aggregate No. 2 Type & Source:	
Aggregate No. 3 Type & Source:	
Aggregate No. 4 Type & Source:	manf sand EC A85006 M.M.
Aggregate No. 5 Type & Source:	sand A85510 Hallett Matl
Aggregate No. 6 Type & Source:	
Aggregate No. 7 Type & Source:	
Aggregate No. 8 Type & Source:	
Cold Feed Sampled By:	Marty Fenmore
Cold Feed Tested By:	Marty Fenmore
Cold Feed Sampling Location:	stream flow
Project No.:	IM-35-5(71)111-13-85
Contract ID:	85-0355-071
County:	Story
Contractor:	Manatt's, Inc.
Mix Class:	
Mix Type:	HMA 1M ESAL
Mix Size:	19 mm
Course Placed:	Shoulders
Lab Voids Specifications:	2.5-4.0
Filler Bitumen Ratio Specifications:	0.6-1.4
Gsb From 956:	2.595
VMA at Recommended %Binder from 956:	13.85
Certified Technician's Name:	Marty Fenmore
Certification No.:	CI 401
Certified Technician's Name:	Cindy Dela Rosa
Certification No.:	CI 722
% Binder in the RAP:	4.77
RAP Source:	Millings from Project I-35
RAP Gradation 1 1/2 in. (37.5 mm) Sieve:	100.0
RAP Gradation 1 in. (25 mm) Sieve:	100.0
RAP Gradation 3/4 in. (19 mm) Sieve:	99.0
RAP Gradation 1/2 in. (12.5 mm) Sieve:	93.0
RAP Gradation 3/8 in. (9.5 mm) Sieve:	84.0
RAP Gradation #4 (4.75 mm) Sieve:	51.0
RAP Gradation #8 (2.36 mm) Sieve:	36.0
RAP Gradation #16 (1.18 mm) Sieve:	29.0
RAP Gradation #30 (600 um) Sieve:	23.0
RAP Gradation #50 (300 um) Sieve:	15.0
RAP Gradation #100 (150 um) Sieve:	9.8
RAP Gradation #200 (75 um) Sieve:	7.8

DESIRED UNITS	
English	Metric
	x

"X" One Box Each

TYPE OF MIX	
Gyratory	Marshall
x	

N-design	Marshall Blows
68	

Gyratory Correction Factor

Expected Mg's. Produced For The Day:	2,177.00			
First Hot Box Sample Megagrams:	204.00	--	500.00	First Sublot = (megagrams)
Second Hot Box Sample Megagrams:	576.00	--	559.00	Second Sublot = (megagrams)
Third Hot Box Sample Megagrams:	1,112.00	--	559.00	Third Sublot = (megagrams)
Fourth Hot Box Sample Megagrams:	1,952.00	--	559.00	Fourth Sublot = (megagrams)

Daily Tank Stick For Virgin Binder Content

Tank No.:	1	2	3	4
Starting Time:	5:45 AM	5:45		
Tank Capacity (Liters):	77,982	77,982		
Outage (% of Diameter):				
Direct Reading (Liters):	58,325	76,185		
Beginning Temp. °C:	148.9	137.8		
Beginning Corrected Liters:	124,056			
Total Kilograms Binder Added During Day:	89,180			
Kilograms/Liter:	1.0265	1.0265		
Added Corrected Liters:	86,878			
Ending Time:	7:00 AM	7:00		
Outage (% of Diameter):				
Direct Reading (Liters):	75,148	20,262		
Ending Temp. °C:	148.9	137.8		
Ending Corrected Liters:	87,775			
Total Kilograms Of Binder Used:	126,423			
Total Kilograms Of Mix Made:	3,416,748			
Total Kilograms Of Mix Wasted:	127,813			
Net Mg's Of Binder Used On Road =	**121.69**			
Net Mg's Of Mix Used On Road =	**3,288.94**			
Percent Virgin Binder By Tank Stick =	**3.70**			

Asphalt Binder Sp. Gr. (Gb)
1.0265
Total Kilograms Of Binder Used By Flow Meter or Batch Totals

Lab. No.:	MEF-CF-36A
Orig. Dry Mass:	2,153.4
Dry Mass Washed:	2,124.3
Total Minus 4.75mm (W1):	1,155.7
Reduced Minus 4.75mm (W2):	567.0
Conversion Factor:	2.0383

Only use green colored cells when (Using Box & 203mm Sieves).

Sieve Size	Reduced Minus 4.75	Total or Calc Mass Retd.	% Retd.	% Passing	Reported Final	Composite % Psg.	Reported Final	Specs.
37.5mm				100.0	100	100.0	100	
25mm				100.0	100	100.0	100	100
19mm				100.0	100	99.6	100	93-100
12.5mm		354.8	16.6	83.4	83	86.4	86	80-90
9.5mm		298.0	13.8	69.6	70	74.9	75	67-81
4.75mm		315.7	14.7	54.9	55	53.6	54	48-62
2.36mm	87.0	177.3	8.2	46.7	47	43.2	43	38-49
1.18mm	110.2	224.6	10.4	36.3	36	33.5	34	
600um	161.8	329.8	15.3	21.0	21	21.7	22	14-24
300um	142.1	289.6	13.4	7.6	7.6	10.1	10	
150um	57.3	116.8	5.4	2.2	2.2	4.8	4.8	
75um	8.3	16.9	0.8	1.4	1.4	3.6	3.6	2.0-6.1
Pan	0.5	1.0	1.4					
Wash		29.1						
Totals	567.2	2,153.6	100.0					
Tolerances	100.0	100.0						

800241 - 07/00 ver. 1.1

DAILY HMA PLANT REPORT

Project No.: IM-35-5(71)111-13-85
Contract ID: 85-0355-071
Mix Design No.: 1BD9-016

Contractor: Manatt's, Inc.
County: Story
Recycle Source: Millings from Project I-35

Class:
Size: 19 mm
Mix Type: HMA 1M ESAL

Report No.: 36
Design Blows:
Design Gyrations: 68

Hot Box I.D. No.:		MEF-HB-36A	EF-HB-36B	EF-HB-36C	EF-HB-36D	
Date Sampled:		09/15/01	09/15/01	09/15/01	09/15/01	
Gradation ID:	Specs	EF-CF-36A				DOT
1 in. (25mm) Sieve	100	100				100
3/4 in. (19mm) Sieve	93-100	100				100
1/2 in. (12.5mm) Sieve	80-90	86				85
3/8 in. (9.5mm) Sieve	67-81	75				74
* #4 (4.75mm) Sieve	48-62	54				54
* Moving Average						
* #8 (2.36mm) Sieve	38-49	43				43
* Moving Average						
#16 (1.18mm) Sieve		34				33
* #30 (600um) Sieve	14-24	22				21
* Moving Average						
#50 (300um) Sieve		10				10
#100 (150um) Sieve		4.8				4.9
* #200 (75um) Sieve	2.0-6.1	3.6				3.5
* Moving Average						
Compliance (Y/N)						
Intended Added, % Binder	3.90					
Actual Added, % Binder		3.70				
Intended Total, % Binder	5.52					
Actual Total, % Binder		5.35				5.35
Gmb:		2.374	2.380	2.375	2.402	2.386
Gmm:		2.455	2.452	2.451	2.460	2.45
Pa:		3.3	2.9	3.1	2.4	2.6
Moving Average	2.5-4.0	**3.4**	**3.4**	**3.3**	**2.9**	
Time		8:15 AM	11:00 AM	2:30 PM	5:00 PM	This
Station		124+53	256+12	333+33	425+21	Column
Side		NB	NB	NB	NB	Is For
Sample Mg's		362.00	743.00	1,111.00	2,148.00	Dist. Lab
Sublot Mg's		500.00	559.00	559.00	1,670.94	Test
Mg's to Date		38,169.04	38,669.04	39,228.04	39,832.98	Results
Fines / Bitumen Ratio	0.6-1.4	0.82				0.80

Gsb: 2.595 Gb: 1.0265 Effective % Binder: 4.37

Mix Change Information: Raised Binder Content 0.1% BEFORE START UP

Time	7:00	9:00	11:00	1:00	3:00	5:00	7:00
Air Temp. °C	14.4	15.5	16.7	17.8	19.4	17.8	
Binder Temp. °C	148.9	148.9	148.9	148.9	148.9	148.9	
Mix Temp. °C	142.8	145	143.9	144.4	143.3	147.2	

Date Placed: 09/15/01 Date Tested:

Course Placed: Shoulders Tested By:

Density Record

Core No.:	1	2	3	4	5	6	7
Station							
CL Reference							
W 1 Dry							
W 2 in H20							
W 3 Wet							
Difference							
Field Density							
% Density							
% Voids							
Thickness (mm)							

Gmb (Lot Avg.): **2.383** Avg. Field Density:
Gmm (Lot Avg.): **2.455** Avg. % Density:
Dist. Labs Pa: Avg. % Field Voids:
Target % RAP: **36.0** Specified % Density:

Q.I. = -- =

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

Film Thickness (FT): **9.6** VMA: **13.1** D.O.T. Results Used:

Remarks:

Certified Tech.: Marty Fenmore CI 401 Cert. No.
Certified Tech.: Cindy Dela Rosa CI 722 Cert. No.

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

5-22

Film Thickness & VMA

Sieve Analysis % Passing													
Sieve	37.5	25	19	12.5	9.5	4.75	2.36	1.18	600um	300um	150um	75um	
Gradation	100	100	100	86	75	54	43	34	22	10	4.8	3.6	
Surface Area Coefficient						0.0041	0.0082	0.0164	0.0287	0.0614	0.1229	0.3277	Total
Surface Area m2 / kilogram					+0.41	0.22	0.35	0.56	0.63	0.61	0.59	1.18	4.55
													SA

Pb= 5.35 % Actual Total, % Binder
Gb= 1.0265 From Binder Supplier
Gsb= 2.595 From Mix Design Information
Gmm= 2.455 From Daily Test Data

Aggregate Effective Sp. Gr. = $\frac{100.0 - 5.35}{(100.0 / 2.455) - (5.35 / 1.0265)}$ = 2.665 Gse

Percent Absorbed Binder = $\frac{100.0 \; (2.665 - 2.595) \; 1.0265}{(2.665)\;(2.595)}$ = 1.04 % Pba

Effective % Binder Content = $5.35 - \frac{(1.04)\;(94.65)}{100.0}$ = 4.37 % Pbe

Film Thickness = $\frac{4.37 \times 10}{(4.55)}$ = 9.6 microns

VMA = 100 - ((2.383 X 94.65) / 2.595)) = 13.1 %

Daily Production Summary

Type	Course		Mg's of Mix Produced:	3,416.75
HMA 1M ESAL	Shoulders		Mg's Of Binder Produced:	126.42
			Megagrams Wasted:	127.81

	Type or Source	%	
Mg's Of RAP In Mix Produced:	Millings from Project I-35	36.0	1,138.51
Mg's Of Agg 1 In Mix Produced:	19 mm CL CHIP EC A85006	27.0	853.88
Mg's Of Agg 2 In Mix Produced:			
Mg's Of Agg 3 In Mix Produced:			
Mg's Of Agg 4 In Mix Produced:	manf sand EC A85006 M.M.	9.0	284.63
Mg's Of Agg 5 In Mix Produced:	sand A85510 Hallett Matl	28.0	885.50
Mg's Of Agg 6 In Mix Produced:			
Mg's Of Agg 7 In Mix Produced:			
Mg's Of Agg 8 In Mix Produced:			

Daily RAP Record

Project No.: IM-35-5(71)111-13-85 Contract ID.: 85-0535-71

Date	Totalizer Readings Agg. (Tons)	RAP (Tons)	Totalizer RAP To Date	RAP Today (%)	Total Mix Wasted (Tons)	Virgin Tank Stick	Virgin Binder In Mix (Tons)	Mix Wasted - Binder (Tons)	RAP Waste Today (Tons)	RAP Used To Date (Tons)	By
09/12/99	1,825.32	1,025.30	1,025.30	35.97	1.27	3.71	0.05	1.22	0.44	**1,024.86**	jr
09/14/99	1,625.21	921.35	1,946.65	36.18	12.33	3.75	0.46	11.87	4.29	**1,941.92**	jr
09/15/99	1,346.57	757.40	2,704.05	36.00	127.81	3.70	4.73	123.08	44.31	**2,655.01**	jr

Todays Date:	05/16/01
Report No.:	2
Expected Tons Produced For The Day:	3,800
Mix Design Number:	ABD8-1007 R1
Gradation Spec. 1 in. (25 mm) sieve:	100
Gradation Spec. 3/4 in. (19 mm) sieve:	98-100
Gradation Spec. 1/2 in. (12.5 mm) sieve:	82-96
Gradation Spec. 3/8 in. (9.5 mm) sieve:	68-82
Gradation Spec. #4 (4.75 mm) sieve:	34-48
Gradation Spec. #8 (2.36 mm) sieve:	22-32
Gradation Spec. #30 (600 um) sieve:	8-16
Gradation Spec. #200 (75 um) sieve:	3.0-4.6
% RAP in mix:	na
Intended Added % Binder:	5.20
Intended Total % Binder:	5.20
% Aggregate No. 1 in Mix:	25.0
% Aggregate No. 2 in Mix:	20.0
% Aggregate No. 3 in Mix:	35.0
% Aggregate No. 4 in Mix:	20.0
% Aggregate No. 5 in Mix:	
% Aggregate No. 6 in Mix:	
% Aggregate No. 7 in Mix:	
% Aggregate No. 8 in Mix:	
Aggregate No. 1 Type & Source:	3/4" cr. Lmst. A77009
Aggregate No. 2 Type & Source:	3/4" clean A77009
Aggregate No. 3 Type & Source:	1/2" chips A77009
Aggregate No. 4 Type & Source:	sand A77555
Aggregate No. 5 Type & Source:	
Aggregate No. 6 Type & Source:	
Aggregate No. 7 Type & Source:	
Aggregate No. 8 Type & Source:	
Cold Feed Sampled By:	Ray Johnson
Cold Feed Tested By:	Ray Johnson
Cold Feed Sampling Location:	stream flow
Project No.:	NHS-6-3(41)--12-77
Contract ID:	77-0006-41
County:	Polk
Contractor:	Quality Asphalt, Inc.
Mix Class:	
Mix Type:	HMA Marshall
Mix Size:	3/4"
Course Placed:	Surface
Lab Voids Specifications:	3.5-5.0
Filler Bitumen Ratio Specifications:	0.3-1.2
Gsb From 956:	2.601
VMA at Recommended %Binder from 956:	
Certified Technician's Name:	Ray Johnson
Certification No.:	C1213
Certified Technician's Name:	John Rayson
Certification No.:	C1312
% Binder in the RAP:	
RAP Source:	
RAP Gradation 1 1/2 in. (37.5 mm) Sieve:	
RAP Gradation 1 in. (25 mm) Sieve:	
RAP Gradation 3/4 in. (19 mm) Sieve:	
RAP Gradation 1/2 in. (12.5 mm) Sieve:	
RAP Gradation 3/8 in. (9.5 mm) Sieve:	
RAP Gradation #4 (4.75 mm) Sieve:	
RAP Gradation #8 (2.36 mm) Sieve:	
RAP Gradation #16 (1.18 mm) Sieve:	
RAP Gradation #30 (600 um) Sieve:	
RAP Gradation #50 (300 um) Sieve:	
RAP Gradation #100 (150 um) Sieve:	
RAP Gradation #200 (75 um) Sieve:	

DESIRED UNITS	
English	Metric
x	

"X" One Box Each

TYPE OF MIX	
Gyratory	Marshall
	x

N-design	Marshall Blows
	50

Gyratory Correction Factor

Expected Tons Produced For The Day:	3,800.00			
First Hot Box Sample Tons:	190.00	--	500.00	First Sublot = (tons)
Second Hot Box Sample Tons:	533.00	--	1,100.00	Second Sublot = (tons)
Third Hot Box Sample Tons:	2,218.00	--	1,100.00	Third Sublot = (tons)
Fourth Hot Box Sample Tons:	3,025.00	--	1,100.00	Fourth Sublot = (tons)

Daily Tank Stick For Virgin Binder Content

Tank No.:	1	2	3	4
Starting Time:	6:00 a.m.			
Tank Capacity (Gallons):	20,000			
Outage (% of Diameter):	89.2			
Direct Reading (Gallons):				
Beginning Temp. °F:	284			
Beginning Corrected Gallons:	1,077			
Total Pounds Binder Added During Day:	487,524			
Pounds/Gallon:	8.5400			
Added Corrected Gallons:	57,087			
Ending Time:	7:30 p.m.			
Outage (% of Diameter):	56.6			
Direct Reading (Gallons):				
Ending Temp. °F:	293			
Ending Corrected Gallons:	7,667			
Total Pounds Of Binder Used:	431,244			
Total Pounds Of Mix Made:	8,383,797			
Total Pounds Of Mix Wasted:	2,643			
Net Tons Of Binder Used On Road =	**215.55**			
Net Tons Of Mix Used On Road =	**4,190.58**			
Percent Virgin Binder By Tank Stick =	**5.14**			

Asphalt Binder Sp. Gr. (Gb)
1.0252
Total Pounds Of Binder Used By Flow Meter or Batch Totals

Gmb - Test Data	Test 1	Test 1	Test 1	Test 2	Test 2	Test 2	Test 3	Test 3	Test 3	Test 4	Test 4	Test 4
Hot Box ID Number:	SU5-16A			SU5-16B			SU5-16C			SU5-16D		
Hot Box Sample Tons:	190			533			2,218			3,025		
Time:	7:05 a.m.			8:35 a.m.			1:30 p.m.			4:55 p.m.		
Station:	112+55			134+22			189+98			244+55		
Side:	WB			WB			WB			WB		
Compaction Temp. °F:	275			275			275			275		
Specimen ID No.:	2-1A	2-1B	2-1C	2-2A	2-2B	2-2C	2-3A	2-3B	2-3C	2-4A	2-4B	2-4C
Marshall Blows:	50	50	50	50	50	50	50	50	50	50	50	50
Mass In Air:	1,211.2	1,212.5	1210.9	1,214.4	1,213.2	1212.9	1,210.8	1,209.9	1211.6	1,210.8	1,209.8	1210.5
Mass In Water:	700.6	701.2	700	703.3	702.2	701.9	701.1	699.9	702.4	704.5	702.6	703.9
Mass SSD:	1,211.6	1,212.8	1211.5	1,214.9	1,213.7	1213.4	1,211.4	1,210.2	1212.3	1,211.0	1,210.4	1210.8
Measured Density :	2.370	2.370	2.367	2.374	2.372	2.371	2.373	2.371	2.376	2.391	2.382	2.388
Avg. Marshall Density (Gmb):		2.369			2.372			2.373			2.387	
Gmm - Test Data												
Pycnometer No.:		1			1			1			1	
Mass; Container & Sample:		2,020.2			2,025.2			2,021.8			2,022.2	
Mass; Container:												
"W", Sample Mass:		2,020.2			2,025.2			2,021.8			2,022.2	
"W1", Mass Pyc. & H2O @ Test Temp.:		7,229.5			7,229.5			7,229.5			7,229.5	
Total Mass:		9,249.7			9,254.7			9,251.3			9,251.7	
"W2", Mass Pyc. & Water & Sample:		8,431.5			8,437.1			8,435.9			8,435.5	
Mass Displaced Water:		818.2			817.6			815.4			816.2	
Test Temperature Of Water (°F):		77			77			77			77	
R Multiplier (chart):		1.0000			1.0000			1.0000			1.0000	
(Gmm):		2.469			2.477			2.480			2.478	
Pa - Test Data:		4.1			4.2			4.3			3.7	
Gyratory Slope:												
Average Slope:												
% Gmm @ N Ini. & N Max.:												

Lab. No.:	GRAD 2-A
Orig. Dry Mass:	2,555.0
Dry Mass Washed:	2,451.0
Total Minus #4 (W1):	
Reduced Minus #4 (W2):	
Conversion Factor:	

Only use green colored cells when (Using Box & 8 in. Sieves).

Sieve Size	Reduced Minus #4	Total or Calc Mass Retd.	% Retd.	% Passing	Reported Final	Composite % Psg.	Reported Final	Specs.
1 1/2 in.				100.0	100			
1 in.				100.0	100			100
3/4 in.		12.5	0.5	99.5	100			98-100
1/2 in.		255.6	10.0	89.5	90			82-96
3/8 in.		408.4	16.0	73.5	74			68-82
#4		888.8	34.7	38.8	39			34-48
#8		336.2	13.2	25.6	26			22-32
#16		185.4	7.3	18.3	18			
#30		163.3	6.4	11.9	12			8-16
#50		112.4	4.4	7.5	7.5			
#100		52.8	2.1	5.4	5.4			
#200		26.1	1.0	4.4	4.4			3.0-4.6
Pan		8.9	4.4					
Wash		104.0						
Totals		2,554.4	100.0					
Tolerances		100.0						

Plant Scale Checks

Project No.: NHS-6-3(41)--12-77 **Contract ID.:** 77-0006-41

		Plant	Scale Weight						
Date	Ticket No.	Weight (lbs)	Truck No.	Gross (lbs)	Tare (lbs)	Net (lbs)	Diff. (lbs)	Comply (Y / N)	By
05/16/98	123	29,680	13	54,360	24,620	29,740	**-60**	y	jr

Plant Site Inspection List (HMA)

Project No.: NHS-6-3(41)--12-77 **Contract ID.:** 77-0006-41

Date Checked	Item	Complies Yes	Complies No	Remarks	By
05/16/98	Foundations	x			
	Bins	x			
	Bin Dividers		x	contractor will fix	
	Supports	x			
	Screens	x			
	Guards	x			
	Ladders	x			
	Railings	x			
	Belt Lockouts	x			
	Asphalt Binder Storage	x			
	Tank Measuring Sticks	x			
	Pollution Control	x			
	Dryer	x			
	Material Scales	x			
	Thermometer Equipment	x			
	Sample Location	x			
	Silo Gates	x			
	Hopper Gates	x			
	Lab Location	x			
	Lab Condition	x			
	Lab Equipment	x			
	QMA Testing Equipment	x			
	Computer	x			
	Fax Machine	x			
	Copying Machine	x			

If an item listed does not apply to the project, write (not applicable) in the remarks column.

Daily Check List (HMA)

Project No.: NHS-6-3(41)--12-77 **Contract ID.:** 77-0006-41

	Stockpiles				Plant Equipment					Scale Sensitivity		Mix Control										
Date	Procedure	Intermingling	Contamination	Segregation	Interlocks	Delivery System	Storage Tanks	Screens	Weigh Belts	AM	PM	Agg. Coating	Mixing Time	Temperatures	Truck Boxes	Truck Loading	Silo Operations	Hopper Gates	Silo Gates	Gate Settings	Agg. Proportion	By:
05/16/98	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	jr

Random Gradations

Project No.: NHS-6-3(41)--12-77 Contract ID.: 77-0006-41

Date	Day	Die Roll	Random Needed	2nd Roll	Sample Tested	Remarks	By
05/15/98	1	3	N				jr
05/16/98	2	4	N				
05/17/98	3	4	N				
05/18/98	4	4	Y	1	3rd		
05/19/98	5	1	N				
05/20/98	6	5	N				
05/21/98	7	3	N				
	1		N				
	2		N				
	3		N				
	4		N				
	5		N				
	6		N				
	7		N				
	1		N				
	2		N				
	3		N				
	4		N				
	5		N				
	6		N				
	7		N				
	1		N				
	2		N				
	3		N				
	4		N				
	5		N				
	6		N				
	7		N				
	1		N				
	2		N				
	3		N				
	4		N				
	5		N				
	6		N				
	7		N				
	1		N				
	2		N				
	3		N				
	4		N				
	5		N				
	6		N				
	7		N				
	1		N				
	2		N				
	3		N				
	4		N				
	5		N				
	6		N				
	7		N				

Tack Shipment Log

Grade: CSS-1H **Source:** Bituminous Materials, DM

Project No.: NHS-6-3(41)--12-77 **Contract ID:** 77-0006-41

Date	Ticket No.	Weight Per Gal	@ 60° F (Gallons)	To Date (Gallons)	Remarks	By
05/16/98	1020	8.4400	2,795	**2,795**	diluted 1:1	jr
05/20/98	1211	8.4400	2,680	**5,475**	diluted 1:1	jr

Hydrated Lime

Source: Linwood

Project No.: NHS-6-3(41)--12-77 **Contract ID.:** 77-0006-41

Date	Totalizer Virgin Agg (Tons)	To Date Virgin Agg (Tons)	Lime Today (Tons)	Lime To Date (Tons)	Today Lime (%)	Remarks	By
05/16/98	3,795.00	3,795.00	40.00	**40.00**	1.05		jr

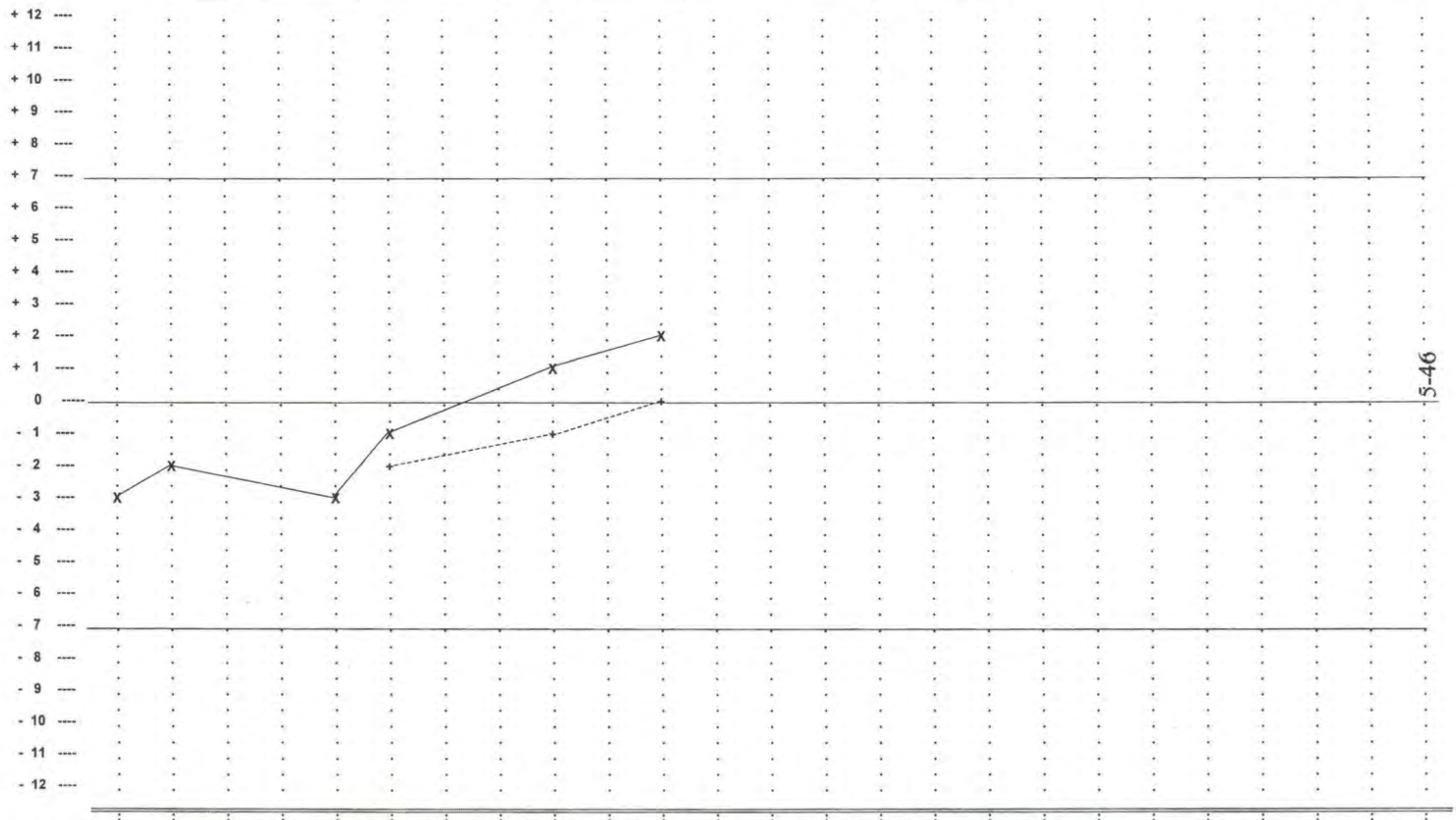
Rev 11/01 | **Project No.:** NHS-6-3(41)--12-77 | **Mix Type:** Surface 30M | **No. 4 Sieve** | **Page No.:** 1 of 1 | Form E227

Contract ID.: 77-0006-41 | **Spec. Limits:** 43-57

County: POLK | **Working Range:** 45-55 | **Initial Target Value:** 50

______ Individual Test

- - - - - Moving Average



Test No.	1-A	1-B			2-A	2-B			3-A		3-C														
Date	5-15				5-16				5-17																
Target	50																								
Revision					R-1																				

Rev 11/01

Project No.: NHS-6-3(41)--12-77 **Mix Type:** Surface 30M

No. 8 Sieve

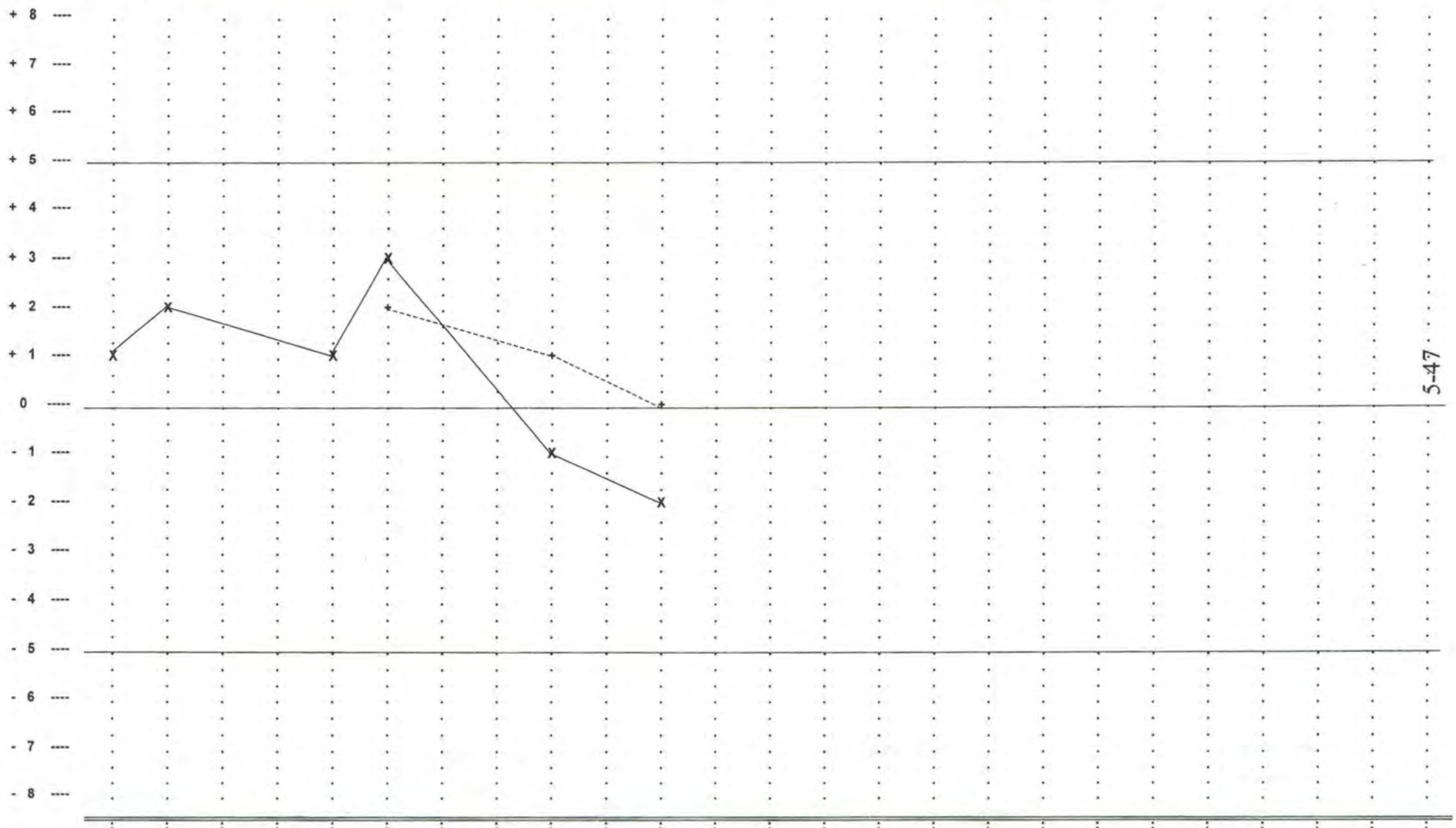
Page No.: 1 of 1 Form E228

Contract ID.: 77-0006-41 **Spec. Limits:** 23-33

____ Individual Test

County: POLK **Working Range:** 24-32 **Initial Target Value:** 28

----- Moving Average



5-47

Test No.	1-A	1-B			2-A	2-B			3-A		3-C														
Date	5-15				5-16				5-17																
Target	28																								
Revision					R-1																				

GUIDANCE TABLES

The tables below are intended to provide guidance on dealing with the most common problems which arise during the production of HMA. The first table deals with problems, which can show up in the laboratory setting and the second table deals with problems, which can appear in the field.

The following example explains how to read the tables. Both tables are read downward. The shaded regions are the items to be considered for adjusting purposes.

Lab Problem Table

The first step is to identify which lab problem is occurring. If "Low Voids" is the identified problem, move down the column to the "Step 1 Check". Assuming the first check is to be made on the "Binder Content", move down the column to "Step 2 If". If the Binder Content is high proceed to "Step 3 Verify". Each of the shaded items identified in the "Step 3 Verify" should be looked at before proceeding further. Assuming that the items in "Step 3 Verify" are on target, go to "Step 4 Do". In this case, the action to be taken in "Step 4 Do" is to "Lower Binder" in the mix.

In <u>all</u> cases, the items in the "Step 3 Verify" are assumed to be within the allowable tolerances and won't fall outside of allowable tolerances if the action in "Step 4 Do" is taken.

LAB PROBLEM		Low Voids			High Voids			Low Film Thickness			High Film Thickness			Low VMA			High VMA		
Step 1-Check	Binder Content	■			■			■			■								
	Gradation		■			■			■			■		■	■		■	■	
	Aggr. SG (Gsb)			■			■									■			■
	Aggr. Absorption									■			■						
Step 2-If	Low Binder				■			■											
	High Binder	■									■								
	Low -200					■						■					■		
	High -200		■						■					■					
	Off JMF Target			■			■			■			■		■	■		■	■
Step 3-Verify	Filler Bitumen Ratio	■	■		■	■		■	■		■	■		■	■		■	■	
	Film Thickness	■	■		■	■								■	■		■	■	
	VMA	■	■		■	■													
	Field Compaction	■	■			■		■	■	■	■	■	■						
	Voids							■	■		■	■		■	■		■	■	
	Individual Aggr. Sources			■			■			■			■			■			■
Step 4-Do	Lower Binder	■									■								
	Increase Binder				■			■											
	Lower -200		■						■					■					
	Increase -200					■						■					■		
	Adjust Aggr. Proportions		■	■		■	■		■	■		■	■	■	■	■	■	■	■
	Recompute Volumetrics			■			■			■			■			■			■

Field Problem Table

The first step is to identify which field problem is occurring. If "High Field Voids" is the identified problem, move down the column to the "Step 1 Check". Assuming the first check is to be made on the "Lab Voids", move down the column to "Step 2 If". If the Lab Voids are high proceed to "Step 3 Verify". Each of the shaded items identified in the "Step 3 Verify" should be looked at before proceeding further. Assuming that the items in "Step 3 Verify" are on target, go to "Step 4 Do". In this case the process of looking at the "Step 3 Verify" would lead to the Lab Problem Table and cause one of the actions for High Lab Voids to be used.

In all cases, the items in the "Step 3 Verify" are assumed to be within allowable tolerances and won't fall outside of allowable tolerances if the action in "Step 4 Do" is taken.

	FIELD PROBLEM	Low Field Voids	High Field Voids	Tender Mix	Low Density Q.I.	Agglomerates	Uncoated Aggr.	Brown Rock	Stripping
Step 1-Check	Stockpiles								
	Aggr. Absorption								
	Binder Content								
	Lab Voids								
	Film Thickness								
	Mixing Time								
	Moisture in Mix								
	Mix Temp at Plant								
	Mat Temp								
Step 2-If	Low								
	High								
	Yes								
Step 3-Verify	Filler/Bitumen Ratio								
	Film Thickness								
	Voids								
	Field Compaction								
	Aggr. Breakdown								
	Individual Aggr. Sources								
	Moisture								
	Amount of Clay Binder								
	Go To Lab Problem Table								
Step 4-Do	Increase Binder								
	Lower Temp								
	Increase Temp								
	Cover Loads								
	Increase Aggr. Dryer Time								
	Screen								
	Adjust Aggr. Proportions								
	Increase Wet Mixing Time								

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