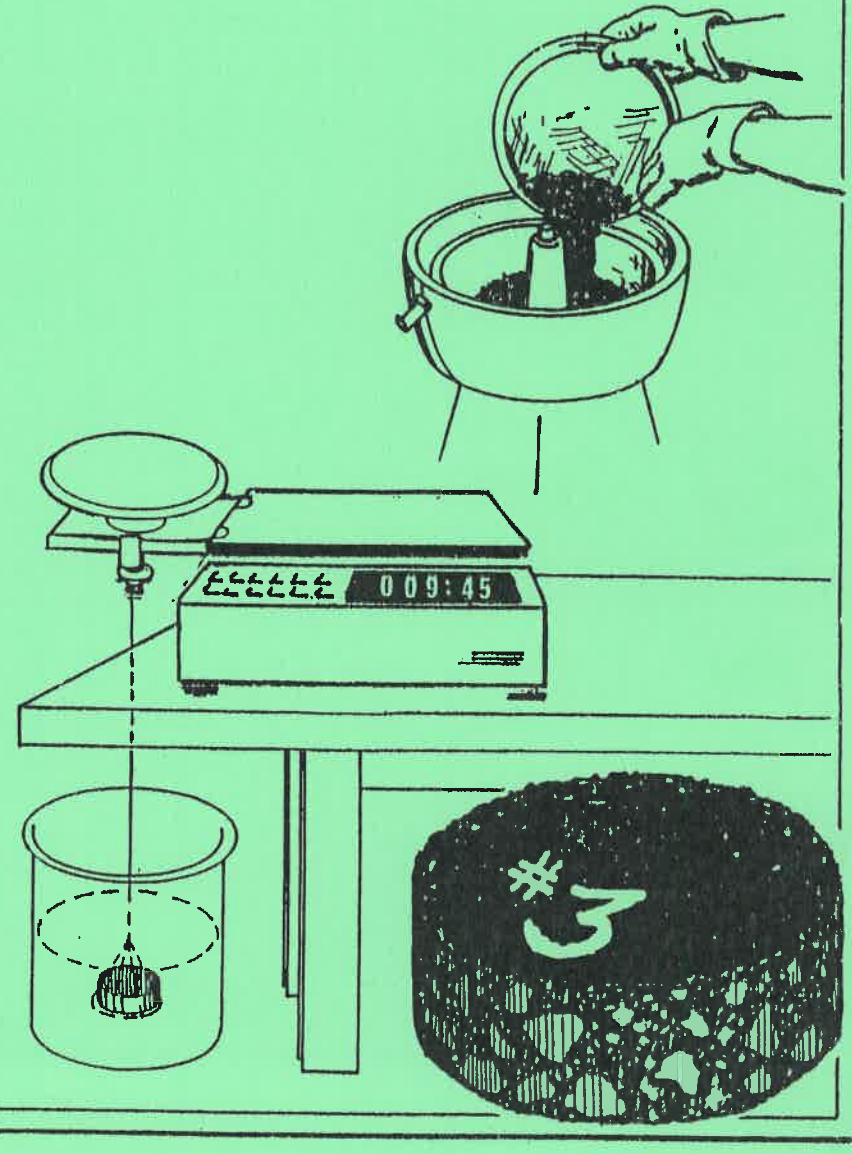
Florida Department of Transportation

HOT MIX ASPHALT TESTING



INTRODUCTION TO HOT MIX ASPHALT TESTING

a training course developed

for the

FLORIDA DEPARTMENT OF TRANSPORTATION

This 2002 revision was carried out under the direction of

The National Center For Asphalt Technology
FDOT Asphalt Technical Review Team
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FOREWORD

Introduction to Hot Mix Asphalt (HMA) Testing is a self-instructional training course that covers the activities required in the obtaining of samples and performing tests related to HMA production and construction. The major areas covered in this course include:

- the terminology of and basic information about what HMA is and the construction of an HMA pavement;
- the procedures for sampling asphalt cement, aggregates and HMA;
- the procedures for conduction gradation testing, extraction testing and determining the density of cores; and
- the methods for computing and documenting the test results.

TABLE OF CONTENTS

DIRECTIONS TO COURSE USERS

TRAINING TECHNIQUE

This course has been designed for self-instructional training:

- You can work alone;
- You can take it as many times as are necessary for learning -- and correct your own mistakes after each quiz; and
- You can finish the training at your own speed.

You will keep this book as your reference, so work neatly.

PREREQUISITES

The Department's State Construction Training Office recommends that you take two courses within the first six months of your employment: Construction Math and Contract Plan Reading. Before taking Introduction to Hot Mix Asphalt Testing, you should have completed at least Construction Math Self-Study Course.

HOW TO USE THIS BOOK

This is not an ordinary book. You cannot read it from page to page as you do other books. This book gives you some information and then asks a series of questions about that information. The questions are asked in such a way that you will have to think carefully and draw some conclusions for yourself. If you have difficulty answering the questions, review the sections that give you trouble before going on.

The answers to the questions are listed at the end of each chapter.

TO MAKE THE BEST USE OF THIS COURSE

Take time to study. Don't expect to learn well by just reading -- you must study.

Studying is not the same as memorizing all the material. Don't try to memorize everything you read. Instead, study well enough to understand everything and remember the main points and the special terms.

Be guided by how well you do on the quizzes in this text. If you cannot answer all the quiz questions easily, restudy the text until you can. If repeated study does not help, get help from your supervisor.

EXAMINATION

An examination has been developed for Introduction to Hot Mix Asphalt Testing.

The examination contains questions and problems with multiple choice answers. To help you prepare for the examination, a Review Quiz is included at the end of this course. If you have no difficulty with the Review Quiz, the examination should present no problems.

CHAPTER ONE

Introduction to Hot Mix Asphalt

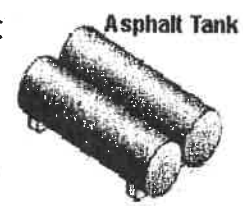
CONTENTS

INTRODUCTION TO HOT MIX ASPHALT

In this introductory chapter, we will discuss hot mix asphalt -- what it's made of, how it is manufactured and how it is placed on the roadway.

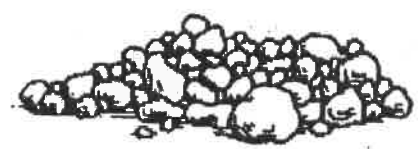
HOT MIX ASPHALT (HMA)

HMA is a mixture of two things:

1. Aggregates  and 2. Asphalt cement 

AGGREGATE

Sand, gravel and crushed stone are aggregates. They are classified as fine or coarse, according to the sizes of the particles. Sand and crushed stone screenings are fine aggregates. Aggregates larger than sand and screenings -- such as crushed stone, crushed gravel and slag -- are coarse aggregates.

Fine aggregates  Coarse aggregates 

ASPHALT CEMENT

Asphalt cement and tar are considered to be bituminous materials or bitumens. Often these terms are used interchangeably due to misconceptions resulting from their similarity in appearance. Tar is manufactured by the distillation of bituminous coal and is rarely used in paving applications. Asphalt cement is a refined product made from a petroleum crude oil. It is a black, cementing material that varies from solid to semisolid at normal air temperature. When heated sufficiently, it softens and becomes a liquid, thus allowing it to coat aggregate particles during hot mix production. When it cools, asphalt cement hardens to hold the aggregate particles together. It is also known as asphalt binder because it “binds” the aggregate together.

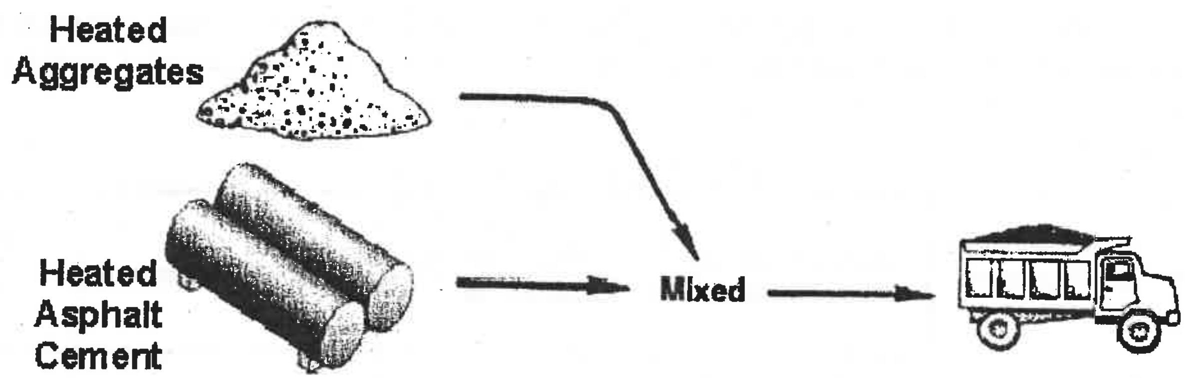
Note that there are differences between "asphalt", "asphalt cement", and "asphaltic concrete". Asphalt cement is one of the many forms of asphalt. Other forms of asphalt -- such as liquid asphalts -- are used to seal road surfaces.

Types of Asphalt Materials

Names of Liquid Asphalts	Rapid Curing (RC) Cutback	Medium Curing (MC) Cutback	Slow Curing (SC) Cutback	Emulsified Asphalt	Inverted Asphalt Emulsion
Ingredients	Gasoline or Naptha	Kerosene	Slowly Volatile & Non Volatile Oils	Water and Emulsifier	Water and Emulsifier
	Asphalt Cement	Asphalt Cement	Asphalt Cement	Asphalt Cement	RC, MC, or SC Liquid Asphalt

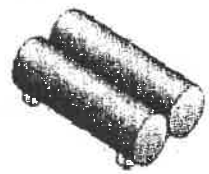
HOT MIX ASPHALT

The aggregates and the asphalt cement are usually heated separately. The asphalt cement is heated in a storage tank and the aggregates are heated in a dryer. Then the hot ingredients are blended to make hot mix asphalt (HMA). The final mixture is approximately 300°F. The HMA (asphalt concrete) is discharged into a truck and taken immediately to the construction site. The mix is placed and compacted while hot. Rollers are used for compaction.



QUIZ

1. The two components of hot mix asphalt are:



(a) ____________________ + (b) ____________________

2. A refined paving asphalt used in hot mix asphalt is ____________________.

3. Sand and crushed stone are two commonly used ____________________ in hot mix asphalt.

4. Aggregates are classified as ____________ or ____________, depending on the sizes of the particles.

The answers to these questions begin on page 1-19.

ASPHALT PLANT OPERATIONS

The basic function of the asphalt plant is to produce HMA containing the correct materials (aggregate and asphalt cement) in the correct percentages. The basic functions of an asphalt plant are:

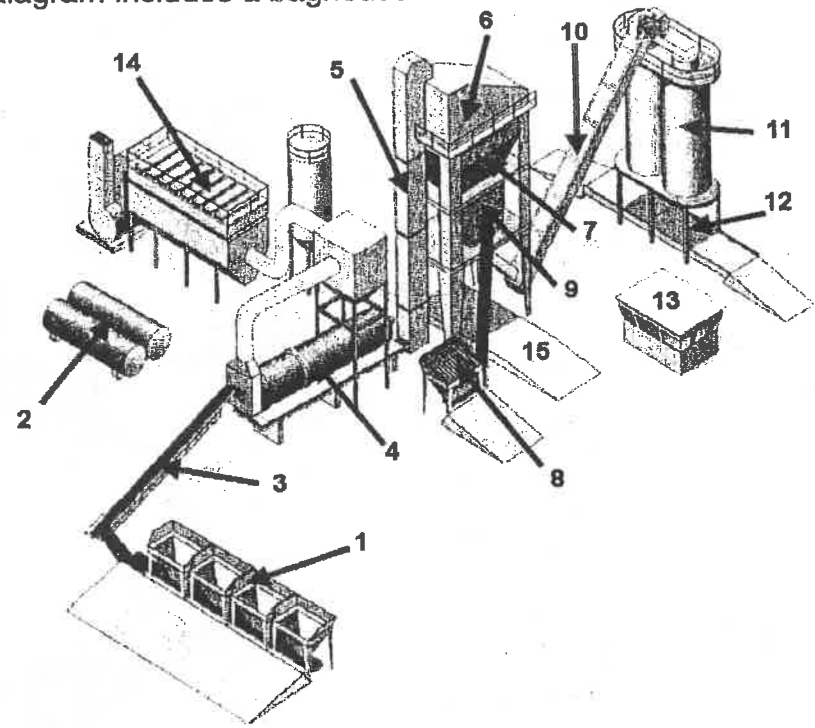
1. Proper storage and handling of HMA component materials
2. Accurate proportioning and feeding of the cold aggregate to the dryer
3. Effective drying and heating of the aggregate
4. Efficient control and collection of the dust from the dryer
5. Proper proportioning, feeding and mixing of the asphalt cement with the heated aggregate
6. Correct storage, dispensing, weighing and handling of the finished HMA

There are two kinds of HMA plants in general use: batch and drum-mix plants. Batch plants mix HMA by placing the correct quantities of aggregate and asphalt cement in a mixer and mixing one "batch" at a time. Drum-mix plants operate without batching units -- by keeping the flow of aggregate and asphalt cement constant, it is mixed to produce asphalt concrete in one continuous process. We will discuss batch plants in this section and drum-mix plants later. A further discussion of asphalt plants is contained in the self-study manual, Hot Mix Asphalt Plant Inspection. A detailed discussion is provided in the three day course Asphalt Plant - Level II presented as a part of the FDOT Construction Training and Qualification Program.

BATCH PLANT OPERATIONS

A diagram showing the basic parts of the batch plant is shown on the next page. Batch plants get their name from the fact that they produce HMA one batch at a time. The size of each batch is controlled by the capacity of the pugmill (9) or mixing chamber where the heated aggregates and asphalt cement are mixed. Typical batch quantities range from 3,000 to 10,000 pounds.

The following will describe the basic process by which material flows through a batch plant. The aggregate is first stockpiled and then moved with a front end loader to the cold feed bins (1) which hold each of the aggregate components and from which the aggregate is proportioned for feeding into the dryer (4). The asphalt cement is stored in either horizontal or vertical storage tanks (2). The aggregate is fed up the cold feed conveyor (3) into the dryer (4) where it is dried and heated to the proper temperature (about 300°F). The aggregate is fed into the hot elevator (5) and then into a screen deck (6) where it is separated into the various sizes that will be used in the production of the HMA. The various sizes of aggregates are stored in hot bins (7). They are combined with the asphalt cement and mixed in the pugmill (9). After the materials are mixed together they can be fed up a conveyor belt (10) to the hot storage silos (or surge bins) (11). If Recycled Asphalt Pavement (RAP) is used, it is added through a separate feeder (8). The completed HMA mixture is loaded into delivery trucks at an area below the storage silos (12) or it can be loaded into trucks immediately below the pugmill (15). The plant operation is controlled from a control house (13). The plant is also equipped with an air pollution control system (14) which in this diagram includes a baghouse.



QUIZ

As a review exercise go through the plant diagram again and indicate the various parts of the plant. This sketch has parts labeled A thru N. Fill in the blanks that correspond with parts labeled below.

A. ______________________________

B. ______________________________

C. ______________________________

D. ______________________________

E. ______________________________

F. ______________________________

G. ______________________________

H. ______________________________

I. ______________________________

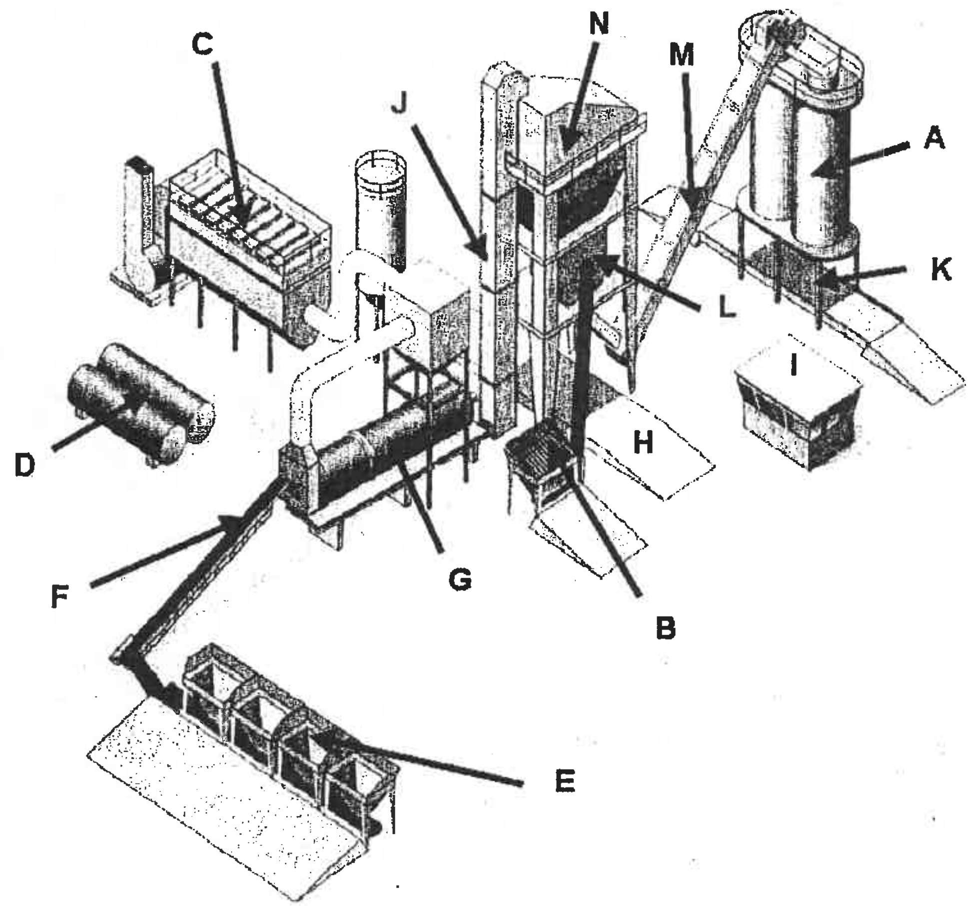
J. ______________________________

K. ______________________________

L. ______________________________

M. ______________________________

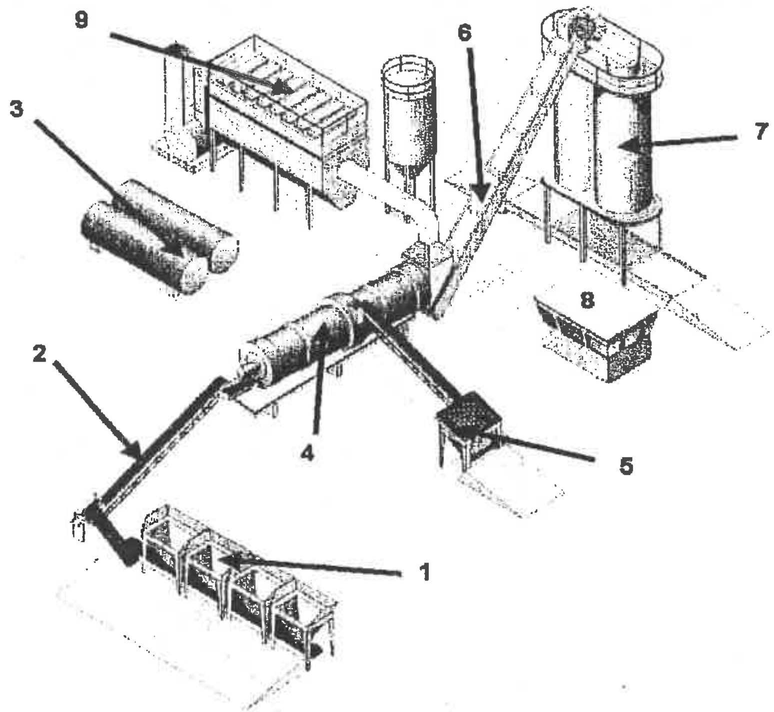
N. ______________________________



The answers can be found on page 1-19.

DRUM-MIX PLANT OPERATIONS

The figure below shows the parts of a typical drum-mix plant. The major difference between a batch plant and a drum-mix plant is where the asphalt cement and aggregates are mixed. In the batch plant, they are mixed batch by batch in the pugmill. In the drum-mix plant, they are typically mixed in the same drum that is used to heat the aggregate. The basic parts of a typical drum-mix plant are shown in the illustration and outlined below. A drum-mix plant has no screening unit, hot bins, or pugmill. Aggregate gradation is controlled at the cold bins and the drum both dries the aggregate and mixes it with the asphalt cement. Other parts of the plant are similar to a batch plant.



As you read this paragraph refer to the figure on the preceding page and follow the flow of the aggregate through the drum mix plant. As in the batch plant the individual aggregate components are deposited in the cold feed bins (1) from which they are fed onto the cold feed conveyor (2). An automatic weighing system monitors the weight of the aggregate flowing into the drum mixer for heating and drying. The weighing system is interlocked with the controls on the asphalt storage pump that draws the asphalt cement from a storage tank (3) and introduces it into the drum (4). The asphalt cement and the heated aggregates are mixed in the drum mixer (4). If recycled asphalt pavement (RAP) is included in the HMA mixture it is fed from a separate bin (5). From the drum mixer the hot mix asphalt is transported by conveyor (6) to a surge bin or storage silo (7), from which it is loaded into trucks and hauled to the paving site. The entire operation is controlled from a control house (8). A dust collection system captures the excess dust escaping from the drum (9).

QUIZ

As a review exercise go through the plant diagram again and indicate the various parts of the plant. This sketch has parts labeled A thru H. Fill in the blanks that correspond with parts labeled below.

A. ______________________________

B. ______________________________

C. ______________________________

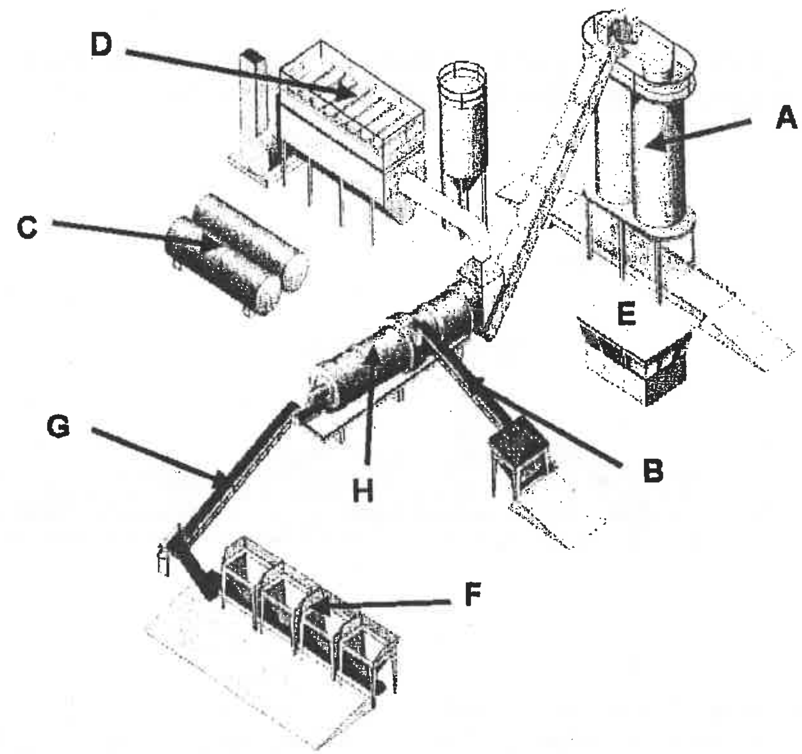
D. ______________________________

E. ______________________________

F. ______________________________

G. ______________________________

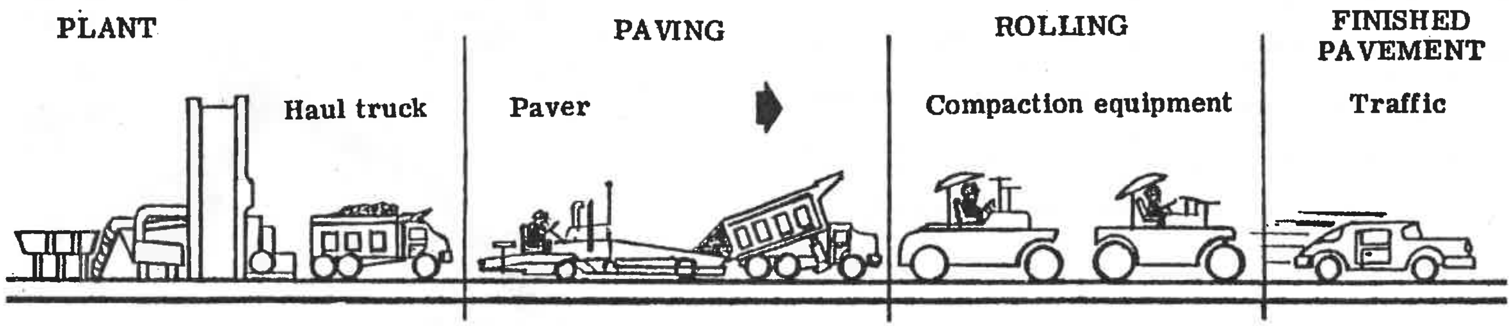
H. ______________________________



The answers begin on page 1-19.

HOT MIX ASPHALT CONSTRUCTION

Asphalt concrete paving consists of placing hot mix asphalt (HMA) on the roadway to provide a durable, smooth riding surface. In simplified form, the operation -- from plant to finished pavement -- is shown below.

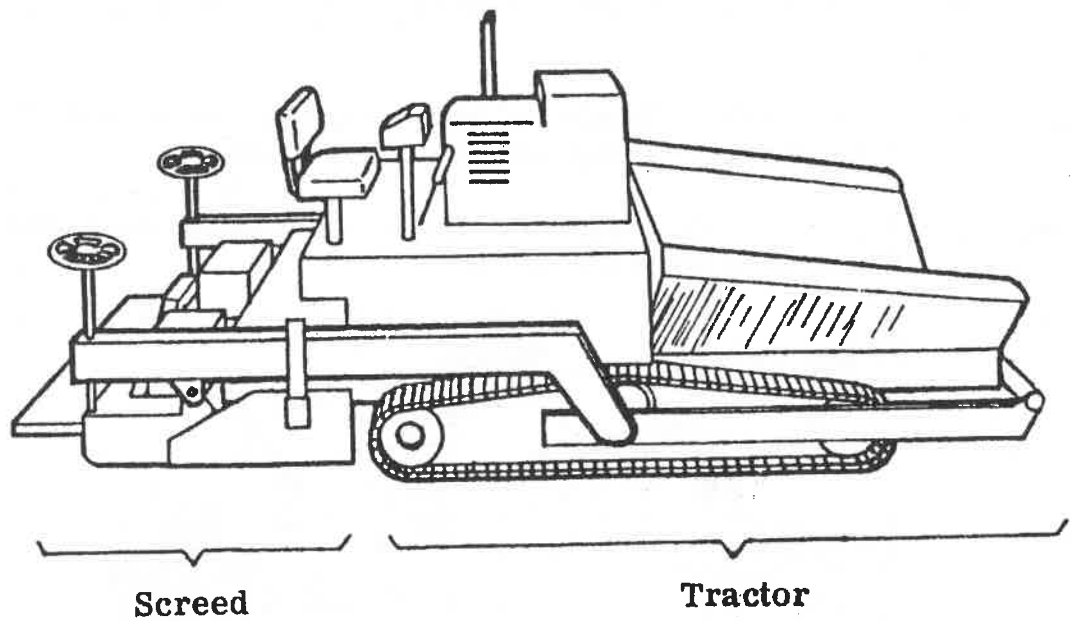


Whether placed as a result of new construction or resurfacing, HMA is the part of the roadway that the public notices the most -- in both riding quality and appearance. More detail is provided on pavement construction in the self study course, Hot Mix Asphalt Paving Inspection, and in the Asphalt Paving - Level II course being taught as a part of the FDOT Construction Training and Qualification Program (CTQP).

PAVER OPERATIONS

One of the most interesting machines used on paving projects is the paver. This machine "paves" the roadway by placing a hot mixture of asphalt cement and aggregates in a smooth-surface mat.

Pavers may appear complex, but they are actually quite simple. All pavers have two basic parts: a tractor and a screed.

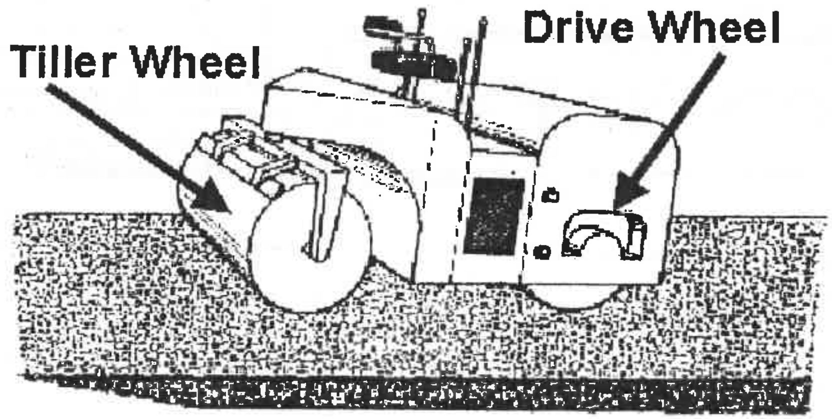


COMPACTION

Once the hot mix is on the roadway, it must be compacted. The purpose of compaction is to increase the **density** of the hot mix -- thereby making the roadway more stable, durable, and pleasing to the traveling public. Compaction is accomplished by rolling -- rollers must be used properly to attain good results. We will discuss the proper use of rollers in a moment.

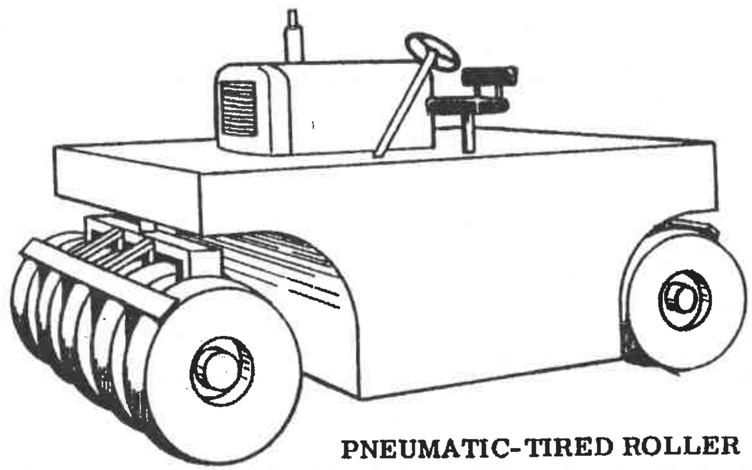
First, we should say a few things about density. **Density** and **compaction** go hand-in-hand. **Density** -- weight per unit volume -- depends on the amount of **compaction. Compaction** results in **density.**

Self-propelled rollers are required for compaction of the HMA. Typical self-propelled rollers consist of the following types: static steel-wheeled, pneumatic tire rollers, and vibratory rollers.



Typical static steel-wheeled rollers have steel drums mounted on two tandem axles. They weigh from 3 to 14 tons. They usually have one powered drum, the drive wheel and one non-powered drum, the tiller wheel. The roller's direction of travel should be such that the powered wheel passes over the uncompacted HMA mixture first. The gross weight of the roller can usually be altered by adding ballast to the roller, but this adjustment cannot be made while the roller is operating, and is not normally changed during the term of a project.

Pneumatic tired rollers have rubber tires instead of steel wheels or drums. They generally feature two tandem axles with 3 to 4 tires on the front axle and 4 to 5 tires on the rear axle. The specifications require that the roller have at least seven wheels. The wheels oscillate; that is, they move up and down independently of each other. Thus, they provide a kneading action to the HMA mixture. They can be ballasted so that their total gross weight can vary from 10 to 35 tons.



PNEUMATIC-TIRED ROLLER

The third type of roller is the vibratory roller which provides the compactive force by a combination of weight and vibration from their steel drums. They look very similar to the static steel-wheeled roller discussed above. The compaction is provided by a rotating eccentric weight inside the drum. The rollers vary in weight from 7 to 17 tons. There are two basic types - double drum (tandem) and single drum. The amount of compaction force that they apply the HMA mat is dependent on the weight of the roller, the impact force provided by the roller (vibration) and the vibration response of the mix.

The decision as to which rollers to use on a project is based on the control strip for Marshall mixes and the test strip for Superpave mixes. More detail is provided on compaction and rollers in the self study course, Hot Mix Asphalt Paving Inspection, and in the Asphalt Paving - Level II course being taught as a part of the FDOT Construction Training and Qualification Program (CTQP).

QUIZ

1. The purpose of compaction is ____.

2. Three types of rollers are:

   a. ____________________________________
   b. ____________________________________
   c. ____________________________________

3. Vibratory rollers achieve compaction through ________________ and ____________________________.

Check your answers on page 1-19, if you got the right answers, continue - if not go back over the material.

ANSWERS TO QUESTIONS

Page 1-5

1. (a) aggregates
   (b) asphalt cement
2. asphalt cement
3. aggregates
4. coarse or fine

Page 1-9

A. Surge bins or storage silos
B. RAP Bins
C. Air pollution control system (Baghouse)
D. Asphalt Storage Tanks
E. Cold feed bins
F. Cold feed conveyor
G. Dryer
H. Loading ramp for pugmill loading
I. Control room
J. Hot elevator
K. Loading ramp for surge bins or storage silos
L. Pugmill
M. Conveyor to surge bins or storage silos
N. Screen deck

Page 1-11

A. Surge bins or storage silos
B. Rap feeder
C. Asphalt storage tanks
D. Baghouse
E. Control Room
F. Cold feed bins
G. Cold feed conveyor
H. Drum mixer

Page 1-15

1. tractor, screed
2. hopper
3. It strikes off and partially compacts the mix.

Page 1-18

1. To increase the density of the HMA mix
2. a. Steel wheeled
   b. pneumatic
   c. vibratory
3. Weight and vibration of the drum

CHAPTER TWO

Introduction to Testing

CONTENTS

INTRODUCTION TO TESTING

SAMPLES AND TESTS

In order to ensure that high-quality hot mix asphalt is used by the State, the components of hot mix, the freshly produced mix and compacted specimens of the mix from the road must be sampled and tested. The Code of Federal Regulations, 23 CFR, Part 637, and the Quality Assurance Procedures for Construction state that all sampling and testing data that is used in the acceptance decision or for independent assurance will be executed by qualified sampling and testing personnel. This self-study course is one of a series of courses being taught under the FDOT's Construction Training and Qualification Program (CTQP), which is the mechanism the Department uses to develop qualified personnel.

AGGREGATES

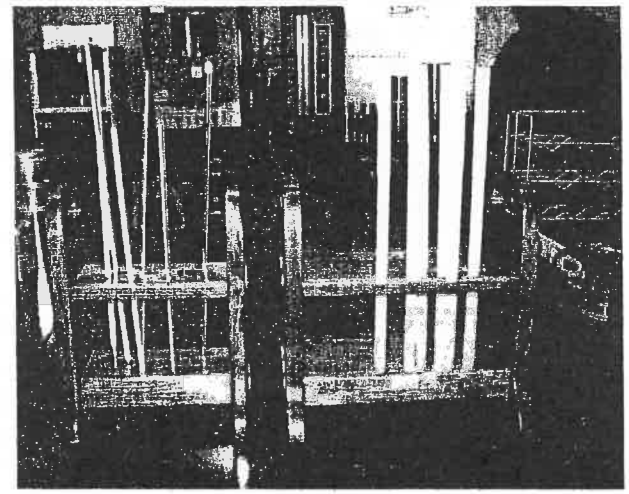
One common test performed on aggregates is a gradation (or sieve) analysis. A gradation analysis determines the relative proportions of the different sizes of aggregate and mineral filler particles. The Mix Design specifies the requirements for the gradations of aggregates for the particular job. It also specifies the proportions of aggregates, and asphalt cement that should be in the hot mix. Gradation testing on aggregates used in hot asphalt mixtures is accomplished in accordance with FM 1-T 030, Mechanical Analysis of Extracted Aggregate.

FRESHLY PRODUCED HOT MIX ASPHALT

Extraction tests on samples of freshly produced hot mix give us two things: the gradation of the aggregates and the percentage of asphalt in the mix. These test results are compared to the Mix Design specifications, to see if the mix is being produced according to design. The extraction test is conducted by the ignition method (FM 5-563).

COMPACTED CORE SAMPLES OF HOT MIX

Roadway core samples are typically furnished by the Paving Technician. Density (specific gravity) tests are performed on them to determine if the compaction operations at the road are achieving the proper density in the pavement. These test results are used to determine payment factors on Superpave and QC 2000 Projects.



FIELD LABORATORY AND TEST EQUIPMENT

Testing and report writing are carried out in a field laboratory located at the asphalt plant site. The Contractor provides this laboratory. The requirements for the laboratory (dimensions, equipment, etc.) are included in the Standard Specifications.

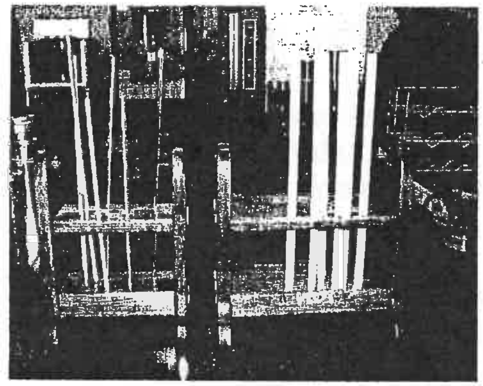
The laboratory must be large enough to contain all the required equipment and facilities and provide enough room for the Quality Control and Verification Technician to perform the tests. It will be your responsibility to use and maintain all test equipment properly and to keep the laboratory in a clean, orderly condition, regardless of whether you work for the contractor, the department, or a consultant.

We will discuss the individual items of test equipment as they come up in the test procedures. But, before we move on to the individual test procedures we want to discuss some general laboratory practices with regard to thermometers and scales.

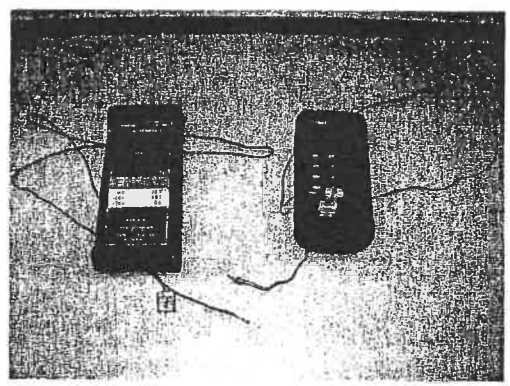
THERMOMETERS

There are two types of thermometers that are typically used in a testing laboratory. These are the traditional glass with mercury column and digital thermometers.

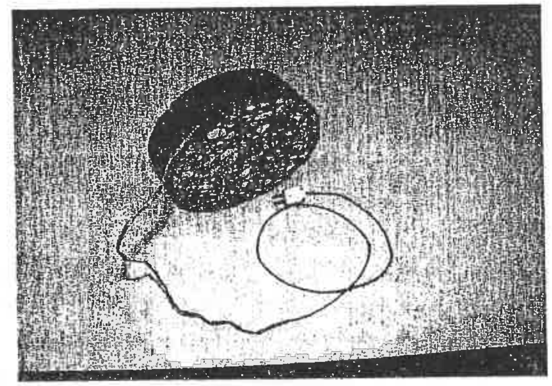
The mercury column in a glass thermometer can separate if they are laid flat. The proper way to store and use them is in the vertical position (upright). If they have been stored flat, you should examine the mercury column prior to using the thermometer for small breaks (air bubbles). If there are any - you should put the thermometer in a freezer until the mercury contracts down into the bottom reservoir. This, generally, should fix the problem.



The second type of thermometer is the digital thermometer which is basically a thermocouple attached to a digital reader. There are several types of thermocouple (T, J, K). The type that is used depends on the thermocouple plug required by the digital reader. Some units can use more than one type.



One advantage of using a digital thermometer instead of traditional thermometers is that the wires can be embedded in a compacted sample. This sample can then be used to indicate how long it takes to thoroughly cool (or heat) a compacted sample.



They can also be used to monitor the temperature of pans of mixes in the oven. The main advantage is that the temperature can be determined without opening the oven door. This minimizes the temperature fluctuations due to opening and closing the oven door and therefore reduces the time it takes to bring samples to temperature.

SCALES

The care and calibration of scales is extremely important. They must be calibrated once each year. Most digital scales have a level bubble. Sometimes these are under the top of the scale. Always make sure that the scale is level before using. If the scale is not level, the results will not be accurate. When mixing asphalt, pieces of mix can get under the top of the scale. If this happens, the platform may not fully rest on the load cells. This will also lead to problems with obtaining repeatable and accurate test results.

Another factor in the accuracy of the scale is the stability of the unit on the counter. It should not rock when the opposite corners of the scale are pressed gently. If the scale does rock, then adjust the levelers until it is stable. Every time a scale is moved from one location to another, it should be quickly checked to make sure it is reading correctly. The easiest way to do this is to have a couple of weights (one at the lower end and one at the upper end of the scale range). Place these on the scale and check the reading. If the digital display does not agree with the known weight, then it may need to be recalibrated.

SAFETY

A materials testing lab is generally a safe work environment but, it is possible to get badly injured. The following common sense safety rules should be followed when working in a testing laboratory:

1. Always wear appropriate eye protection
2. Always wear appropriate protective clothing
3. Never engage in horseplay, pranks or other acts of mischief
4. Be familiar with the location of the eye wash, fire extinguisher, etc.
5. Remember - much of what goes on in the lab deals with HOT materials, therefore, be sure to wear gloves and face shields, when required
6. Report any accident to the supervisor immediately
7. Be familiar with how to deal with asphalt-related burns

If you should get molten asphalt cement on your skin the first step is to COOL the asphalt cement and the affected parts of the body IMMEDIATELY. The methods of cooling in order of preference are:

1. Completely submerge the affected area in ice water
2. Completely submerge the affected area in tap water
3. Place the affected area under running water

DO NOT DELAY - Use any available water, cooler than body temperature, while arranging for better cooling. DO NOT apply ice directly to the affected area. LEAVE cooled asphalt on affected area.

GET THE VICTIM TO A PHYSICIAN as soon as possible.

QUIZ

1. What test is typically performed on aggregate samples? ____________________
2. What test is performed on samples of freshly produced hot mix? ____________________
3. Why are core samples tested? ____
   ____
   ____
4. Who will be responsible for keeping the laboratory clean and orderly? ____________________
5. What are the two types of thermometers? ____________________________________
6. Why do you not store a glass thermometer on its side? ______________________
7. When do you need to check the accuracy of a scale? _________________________

Check your answers on page 2-8, if you got the right answers, continue - if not go back over the material.

Okay, go right on to Chapter Three, ROUNDING.

ANSWERS TO QUESTIONS

<u>Page 2-7</u>

1. Gradation
2. Extraction
3. To determine payment factors on Superpave and QC 2000 projects
4. Laboratory Technicians
5. Glass and digital
6. Because the mercury column can separate
7. Whenever the scale is moved

CHAPTER THREE

Rounding

CONTENTS

ROUNDING

Numbers are rounded for at least two reasons:

1. To provide a stopping point in calculations--particularly in dividing some calculations that otherwise would go on indefinitely.
2. To make numbers easier to use--without sacrificing the degrees of accuracy needed.

To round a decimal number is to reduce the number of digits used.

The number "21.6666" can be rounded to three degrees of decimal accuracy or to the nearest whole number--as follows:

Original Number	Degree of Accuracy	Rounded Number
21.6666	Tenths	21.7
21.6666	Hundredths	21.67
21.6666	Thousandths	21.667
21.6666	Whole Number	22

The digits following the last digit used are dropped. In the first three examples, the last digit used was increased to 7. The decision to increase or not to increase the last digit is based on three "RULES FOR ROUNDING DECIMAL NUMBERS".

ROUNDING DECIMAL NUMBERS

Rounding is done by following three rules:

Rule One --Determine the LAST DIGIT TO BE USED--the last digit needed for accuracy.

If the number is 15.582 is to be rounded to two decimal places--the LAST DIGIT TO BE USED is the "8." The 2 will be dropped.

Rule Two --If the digit following the last digit to be used is 0, 1, 2, 3, or 4--drop it and all that follow it. DO NOT CHANGE the last digit to be used.

As an example, if the following numbers are rounded to one decimal place:

5.90	
5.91	All are rounded to 5.9--the 0, 1, 2, 3 and 4 are
5.92	dropped.
5.93	The 9 remains unchanged.
5.94	

5.901	All are rounded to 5.9. The digits in the
5.9167	second, third and fourth places and all the
5.9499	following decimal places are dropped.

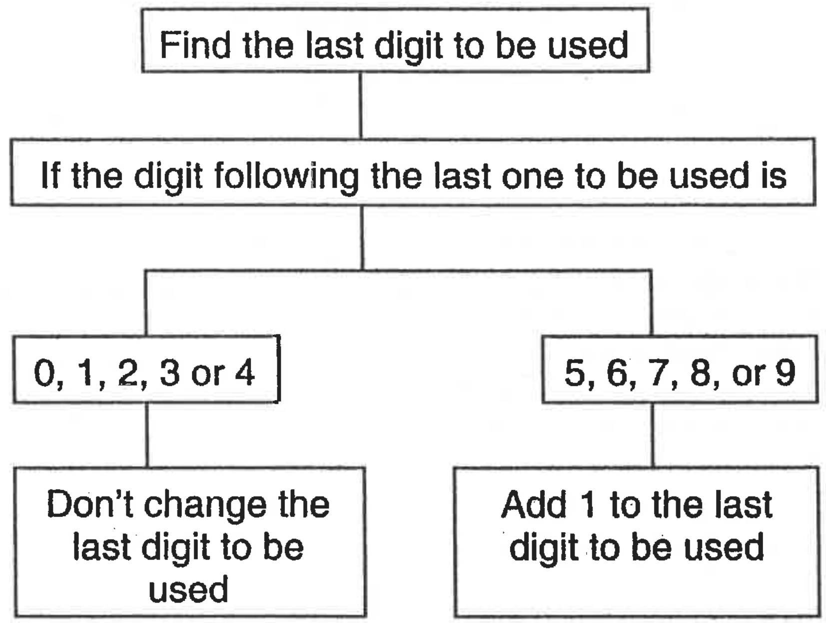
Rule Three --If the digit following the last digit to be used is 5, 6, 7, 8 or 9 -- drop it and all digits that follow it. Add 1 to the last digit to be used.

Example: The following numbers are rounded to one decimal place:

3.45 3.46 3.47 3.48 3.49	All of these numbers are rounded to 3.5--the 5, 6, 7, 8 and 9 are dropped and the value "1" is added to the "4"--the last digit used	3.46 3.4791 3.49899	All are rounded to 3.5. The digits in the third, fourth, and following decimal places are ignored.

SUMMARY

The rules of rounding are diagramed below:



QUIZ

1. Round the following numbers:

From		To	
a.	997.487	Nearest whole number	________
b.	63.7458	Two decimal places	________
c.	92.55	Nearest whole number	________
d.	436.48853	Three decimal places	________

2. Round these numbers to two decimal places:

a. 84.375 ________
b. 9.4656 ________
c. 321.3849 ________
d. 0.9993 ________

3. Round these numbers to three decimal places:

a. 10.7555 ________
b. 0.019500 ________
c. 1.998501 ________
d. 99.9985 ________

Check your answers on page 3-17, if you got the right answers, continue - if not go back over the material.

ROUNDING IN A SERIES OF CALCULATIONS

GENERAL RULE

When is it necessary to make one or more calculations to obtain a final answer, all preliminary answers should be carried out and rounded to one decimal place more than needed in the final answer.

NOTE: All answers calculated prior to the final answer are called "preliminary answers."

An example of the general rule is shown below--where the final answer is to be reported in a whole number:

Areas paved:	510.4 square yards	Preliminary answers will be carried out and rounded to tenths.
	270.1 square yards	
	+121.9 square yards	
Total area paved:	902.4 square yards	
	902 square yards	Final answer will be rounded to a whole number.

Additional examples are provided on the following pages to show how the general rule is applied when calculating final answers to the nearest whole numbers, tenths, hundredths and thousandths.

CALCULATING TO THE NEAREST WHOLE NUMBER

When final answers must be in whole numbers, all preliminary answers will be carried out and rounded to tenths. Final answers will be rounded to the nearest whole numbers.

Example when Multiplying

Preliminary Calculation A	Preliminary Calculation B
10.5 x 2.3 = 24.15	12.5 x 4.6 = 57.50
Rounded to: 24.2	Rounded to: 57.5

Final Calculation
(A x B) = 24.2 x 57.5 = 1391.50
Rounded to: 1392

QUIZ

1. Round the answers in preliminary calculations A and B, below, to tenths (0.1). Round the final answers to the nearest whole number.

A = 5.4 x 2.3 =	12.42 rounded to:	________________
B = 15.6 x 72.8 =	1,135.68 rounded to:	________________
Final Answer = A x B =	14,105.15 rounded to:	________________

Check your answers on page 3 - 17, if you got the right answers, continue on to "CALCULATING TO TENTHS" - if not go back over the material.

CALCULATING TO TENTHS

When final answers must be in tenths, all preliminary answers will be carried out and rounded to hundredths (0.01). Final answers will then be rounded to tenths (0.1).

Example when Multiplying

Preliminary Calculation A	Preliminary Calculation B
25.52 x 13.14 = 335.3328	9.45 x 3.2 = 30.240
Rounded to: 335.33	Rounded to: 30.24

Final Calculation

(A x B) = 335.33 x 30.24 = 10,140.3792

Rounded to: 10,140.4

QUIZ

1. Round the answers in the preliminary calculations below to hundredths (0.01). Round the final answer to <u>tenths</u> (0.1).

A =	12.34 x 7.36 =	90.8224 rounded to:	____________
B =	7.15 x 1.12 =	8.0080 rounded to:	____________
Final Answer =	A x B =	727.3058 rounded to:	____________

Check your answers on page 3 - 17, if you got the right answers, continue on to "CALCULATING TO HUNDREDTHS" - if not go back over the material.

CALCULATING TO HUNDREDTHS

When final answers must be in hundredths (0.01), all preliminary answers must be carried out and rounded to thousandths (0.001). Final answers will be rounded to <u>hundredths</u> (0.01).

Example when Dividing

Preliminary <u>Calculation A</u>	Preliminary <u>Calculation B</u>
542.15 ÷ 28.47 = 19.0428	138.375 ÷ 12.12 = 11.4170
Rounded to: 19.04<u>3</u>	Rounded to: 11.41<u>7</u>

<u>Final Calculation</u>

A ÷ B = 19.043 ÷ 11.417 = 1.667

Rounded to: 1.6<u>7</u>

QUIZ

1. Round the answers in preliminary calculations below to thousandths (0.001). Round the final answer to hundredths (0.01).

   A = 137.29 ÷ 25.16 = 5.4566 rounded to: ____________

   B = 547.15 ÷ 89.28 = 6.1284 rounded to: ____________

Final Answer = B ÷ A = 1.123 rounded to: ____________

Check your answers on page 3-17, if you got the right answers, continue - if not go back over the material.

Right? Excellent! Skip to "CALCULATING TO THOUSANDTHS".
Wrong? Go back and review.

CALCULATING TO THOUSANDTHS

When final answers must be in thousandths (0.001), all preliminary answers will be carried out and rounded to ten-thousandths (0.0001). Final answers will then be rounded to thousandths (0.001).

Example when Adding

Preliminary Calculation A	Preliminary Calculation B
4.46891	3.97163
2.15672	1.05872
1.12013	2.18291
+ 0.01882	+ 1.50562
7.76458	8.71888
Rounded to: 7.7646	Rounded to: 8.7189

Final Calculation

A + B = 7.764 + 8.7189 = 16.4835

Rounded to: 16.484

QUIZ

1. Round preliminary answers A and B to ten-thousandths (0.0001). (Enter the last digit used in the spaces provided.) Subtract the rounded answers: A-B=C. Round the final answer to thousandths.

Preliminary Calculation A	Preliminary Calculation B
15.44792	10.52346
- 12.39627	- 8.32761
3.05165	2.19585

Round to: 3.051__ = A (Preliminary answer)   Round to: 2.195__ = B (Preliminary answer)

Final Calculation: A - B

3.051__ - 2.195__ = ___.____ = C   Enter last digits here – from answers A and B above and subtract.

Rounded to: ___.____ = Final answer

Check your answers on page 3-17, if you got the right answers, continue - if not go back over the material.

ROUNDING IN CONSTRUCTION MATH

In this course, we will use the rules of rounding set forth in this chapter. In practice, you should follow these same rules unless you are given other instructions.

For π (Pi), use 3.14 or 3.142 or 3.1416 as required for the desired degree of accuracy.

ACCURACY

The need to calculate to tenths, hundredths or thousandths depends on the significance of each calculation. In practice, you will learn the accuracy required for specific calculations and situations. If all persons involved in the inspection, payment accounting, and auditing functions of the Department use identical practices with regard to rounding and degrees of accuracy, they will get identical answers in all calculations.

ANSWERS TO PROBLEMS

Page 3-6
1. a. 997
   b. 63.75
   c. 93
   d. 436.489
2. a. 84.38
   b. 9.47
   c. 321.38
   d. 1.00
3. a. 10.756
   b. 0.020
   c. 1.999
   d. 99.999

Page 3-9
1. 12.4
   1,135.7
   14,105.2

Page 3-11
1. 90.82
   8.01
   727.31

Page 3-13
1. 5.457
   6.128
   1.12

Page 3-15
1. 3.0517
   2.1959
   0.8558
   0.856

CHAPTER FOUR

Sampling Asphalt Cement, Aggregate and Hot Mix Asphalt

CONTENTS

SAMPLING ASPHALT CEMENT, AGGREGATE AND HOT MIX ASPHALT

Before any material can be tested, it must be sampled. Sampling a material or product is more than just taking a portion from it.

Proper sampling includes:

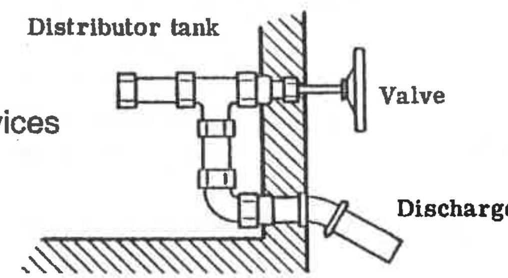
- using and maintaining the proper sampling equipment.
- observing the proper methods for locating and removing samples.
- obtaining samples at the correct frequencies.
- obtaining representative -- typical -- portions of the proper sizes.
- handling samples carefully to avoid contaminating them, changing their properties or losing material.
- reducing initial samples to the smaller quantities required for testing.

In this chapter we will discuss the sampling of asphalt cement, aggregate, and hot mix asphalt. Chapter Six contains a brief discussion of roadway core sampling for density tests. The frequencies and initial sizes of all samples discussed in this course are covered in the FDOT Sampling, Testing and Reporting Guide. The Sampling, Testing and Reporting Guide is discussed in Chapter Seven of this course.

SAMPLING ASPHALT CEMENT

Although the asphalt cement delivered to the plant is normally pretested by the producer, it is the responsibility of the plant technician to obtain samples to submit to the Central Laboratory for testing. You should obtain these samples according to the size and frequency requirements listed in the Sampling, Testing and Reporting Guide.

SAMPLING DEVICE



Asphalt cement samples are obtained through sampling devices attached to the transport truck tanks or distributor tanks. There are two approved types of sampling devices that you will encounter. One of these devices is shown in a simple diagram at right.

SAMPLE CONTAINERS

Samples are discharged from transport or distributor tanks into sample containers. These containers must be new, clean and dry. They should not be washed or rinsed.

Different sample containers should be used for different liquid asphalt materials:

- quart (one-liter) friction-top cans -- for asphalt cements and asphalt rubber.
- quart (one-liter) wide-mouth jars or bottles made of glass or plastic -- for anionic emulsions.
- quart (one-liter) wide-mouth jars or bottles made of plastic, or wide-mouth cans with screwcaps -- for cationic emulsions.

A plastic bottle is shown to the right. Attached to it is a Sample Transmittal Card for submitting the sample to the Laboratory.

We will discuss Sample Transmittal Cards in a few pages. For now, go on to the quiz beginning on the next page.

QUIZ

1. Which of the following may properly be included in our overall description of sampling?
   ___ A. Obtaining samples at the correct frequencies
   ___ B. Reducing initial samples to the smaller quantities required for testing
   ___ C. Separating aggregate particles from one another according to their individual sizes
   ___ D. Using and maintaining the proper sampling equipment

2. Why are you required to sample asphalt cement?
   ___ A. For certification
   ___ B. To perform tests on the samples in the field lab
   ___ C. To submit samples to the Central Lab

3. You obtain asphalt cement samples through ______________________ attached to the transport truck or distributor tanks.

4. Asphalt cement sample containers must be:
   ___ A. clean
   ___ B. square
   ___ C. new
   ___ D. dry
   ___ E. washed

5. Match the following sample containers to the liquid bituminous materials:

___ A.	Anionic emulsions	1.	quart friction-top cans
___ B.	Cationic emulsions	2.	quart wide-mouth jars or bottles
___ C.	Asphalt cements	3.	quart wide-mouth jars or bottles, or wide-mouth cans with screw tops

6. What must be attached to <u>all</u> of the above containers when samples are submitted to the Laboratory?

____

Check your answers on page 4 - 32, if you got the right answers, continue - if not go back over the material.

SAMPLING PROCEDURES

To obtain asphalt cement samples, follow the steps listed below:

1. Be present when the transport truck arrives at the plant or the distributor arrives at the road. Draw off at least one gallon of material from the spigot (sampling device) before taking your sample. Drawing off one gallon or more of material ensures that the spigot is clean and removes any residual cleaning fluids. This ensures that your sample is representative. The one gallon or more of material should be recycled.

2. Now, draw off enough material to fill the sample container. You also are required to obtain a **check sample**. Take it right after drawing off the test sample. Do not transfer samples from one container to another.

3. Seal the sample containers immediately. Emulsion jar lids should be sealed with masking tape. Any spilled material on the containers should be cleaned off with a dry cloth -- **not** with solvent.

4. Complete a Sample Transmittal Card, attach it to each container, and send the test sample to the State Materials Office (SMO). Again, we will discuss Sample Transmittal Cards in a few pages.

Retain the check sample(s) in the field laboratory in case they are needed as backups for the original sample. Check samples should be recycled when a passing report is received for the original sample submitted to the SMO Laboratory. If a failing report is received from the SMO, send the check sample to the lab.

SAFETY - BE CAREFUL - THE ASPHALT CEMENT IS HOT - GLOVES MUST BE WORN.

CERTIFICATION PAPERS

In addition to obtaining and submitting asphalt cement samples, you must also collect the delivery ticket and certification papers for the shipments. These papers certify that the materials met State specifications at the source. Submit these papers with your daily reports to the project office.

QUIZ

1. Should you be present when the transport truck or distributor arrives? ________

2. Before drawing off the sample, draw off and discard at least ________________________ of asphalt cement.

3. When should you draw off the check sample(s) in relation to the test sample? ________________________________

4. Is it good procedure to transfer samples from one container to another? ________

5. How soon after being filled should sample containers be sealed? ________________________________

6. What should you use to clean off material that has spilled on a container? ________________________________

7. What should be attached to the containers before they are sent to the State Materials Office? ____________________ ________________________________

8. What should you do with check sample(s)? ________________________________ ________________________________

9. What should you do with certification papers? ________________________________

Check your answers on page 4 - 32, if you got the right answers, continue on to **SAMPLING AGGREGATE** - if not go back over the previous material.

SAMPLING AGGREGATE

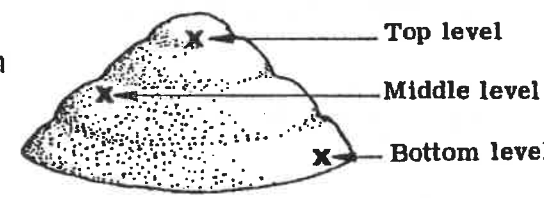
The Plant Technician may be required to sample aggregates for gradation tests that you perform in the field laboratory or for use by the Mix Designer in the development of the mix design. As with asphalt cement, the size and frequency requirements for aggregate samples are listed in the Sampling, Testing and Reporting Guide, or are spelled out in the specifications.

Aggregates may be sampled from several different places, including railroad cars, trucks, barges, boats, stockpiles, conveyor belts, and the hot bins. We will talk about sampling from stockpiles first.

SAMPLING FROM STOCKPILES

The biggest problem with sampling aggregates is segregation -- the separation of the different particle sizes. Segregation can lead to nonrepresentative samples.

To obtain representative samples from stockpiles, sample them at three different levels -- near the top third, middle third and bottom third -- as shown at right.



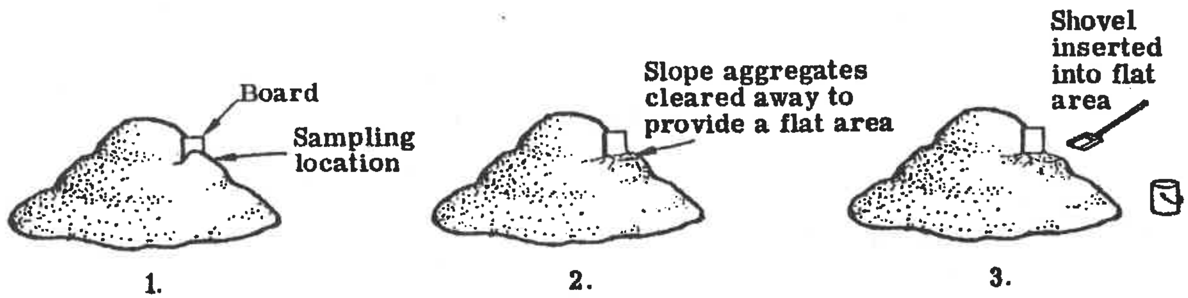
To obtain the sample, use a square-point shovel with turned-up sides to form a scoop and a clean, flat board. Follow these steps:

1. Select the sampling location in the stockpile and insert the board (approximately 12 in. by 24 in.) vertically into the stockpile above it.

2. Clear away the aggregate on the slope below the board until there is a flat, horizontal area for sampling.

3. Insert the shovel into the flat area and remove a scoopful of aggregate, being careful not to spill any particles. Place the aggregate in a bucket.

These steps are shown below:



Repeat the steps for all three sampling locations in the stockpile. Be sure that the sampling locations are not in a vertical line. They should be staggered around the pile, or staggered within whatever portion of the stockpile that must be represented by the sample.

QUIZ

1. You are required to sample aggregates:

   __ A. to develop and to verify mix design formulas.
   __ B. to perform gradation tests in the field lab.

2. The biggest problem with aggregate sampling is avoiding ________________.

3. Which of the following describe the proper sampling locations in stockpiles?

   __ A. From top third, middle third and bottom third levels
   __ B. In a vertical line
   __ C. From middle level only
   __ D. At staggered locations

4. What tools should you use to obtain stockpile samples? ____

   ____

Check your answers on page 4 - 32, if you got the right answers, continue on to **SAMPLING FROM RAILROAD CARS, TRUCKS, BARGES AND BOATS** - if not go back over the material.

SAMPLING FROM RAILROAD CARS, TRUCKS, BARGES AND BOATS

Aggregates in railroad cars, trucks, barges and boats should be sampled from three or more trenches dug across the loads at points that appear on the surface to be representative of the material. The trench bottoms should be at least one foot below the surface of the aggregates and approximately one foot wide. Also, the trench bottoms should be practically level.

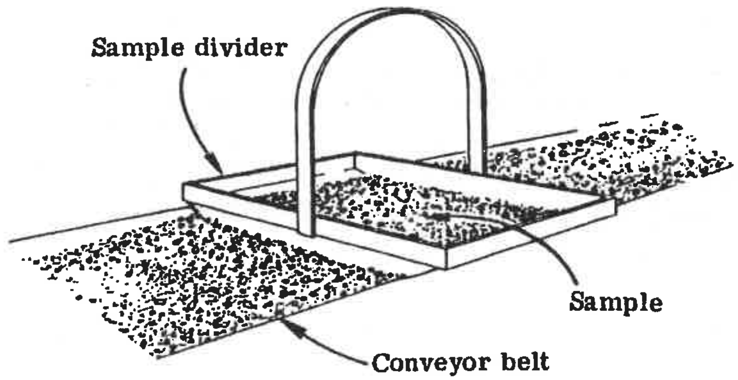
You should use the same type of shovel as discussed for sampling stockpiles. Remove a shovelful of aggregates from each of seven equally spaced points along the trench bottoms. Two of the seven points in each trench should be directly against the sides of the car, truck, or vessel. Be sure to push the shovel downward into the material -- do not scrape the trench bottom horizontally.

Since railroad cars, trucks, barges, and boats vary in size and capacity, you will have to vary the number of trenches that you dig. However, follow the same basic sampling procedures discussed above.

Damp sand may be sampled as discussed above or by means of a sampling tube approximately 1-1/4 inches in diameter and 6 feet long. The tube is inserted into the load from five to eight times, yielding a total sample of about 10 pounds.

SAMPLING FROM CONVEYOR BELTS

To obtain aggregate samples from conveyor belts, **have the plant operator STOP the conveyor**. Next, select a length of belt to give the desired sample size. You must then separate the sample from the rest of the material on the belt by pushing away the material at the ends of the sample. A template or divider that is shaped to the belt's contour is helpful in separating the sample. Such a divider is shown below.



Collect all the aggregates within the divider or sample area -- being sure to collect all the fines as well.

SAMPLING FROM BATCH PLANT HOT BINS

Hot aggregates -- as well as cold aggregates -- must be sampled for gradation tests. Hot aggregate samples should be taken from the individual hot bins. Hot bin facilities for sampling vary from plant to plant, so it is a good idea to become familiar with the plant before the project starts. Many batch plants have automatic sampling devices that are ideal for obtaining representative samples.

If the plant is not equipped with an automatic sampling device, you need a bin sampling device and a bucket for each bin to obtain the samples. The best sampling device is a metal box approximately 12 inches long, 12 inches wide, and 4 inches deep. It should have a handle.

Obtain a sample from each bin, striking off the aggregates flush with the top of the box after each filling. About three or four times the amount of material needed for testing should be taken from each bin. Be sure to avoid mixing the samples from the different bins. Keep them in their individual bin buckets.

You may see other methods of sampling from hot bins, such as dropping the aggregates down through the weigh box and pugmill into a truck or holding a shovel under the bin discharge. These are <u>not</u> accurate methods of sampling and should not be used.

QUIZ

1. Trenches should be dug at least ____________ below the surface of the aggregate at the sides of the load and be ____________ wide at the bottom.

2. When sampling aggregates from trenches:

   ___ A. scrape the bottom horizontally to obtain a shovelful of aggregates.
   ___ B. remove a shovelful of aggregates from each of seven points.
   ___ C. sample from different levels.
   ___ D. space the sampling locations equally.
   ___ E. push the shovel downward into the aggregates.

3. Where must two of the sampling points along each trench be located? ____

4. When sampling wet sand, what approximate dimensions should sampling tubes have? ____

5. What device can help you in separating a sample from the rest of the aggregates on a conveyor belt? ____

6. Should you collect all the fines of the sample from the conveyor belt? ________

7. The hot bins sampling device we described has dimensions of about ____________ long, ____________ wide and ____________ deep.

8. How much material should you remove from each bin -- in relation to the amount needed for testing? ____

9. Which of the following are good procedures?

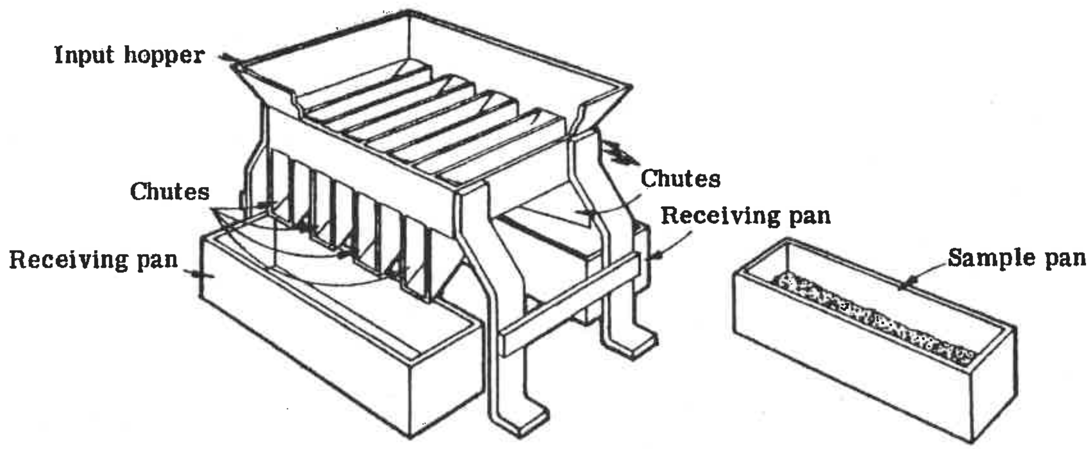
____ A. Keeping bin samples in separate buckets
____ B. Sampling from hot bins by holding a shovel under the bin discharge
____ C. Mixing the individual bin samples thoroughly

Check your answers on page 4-32, if you got the right answers, continue - if not go back over the previous material.

REDUCING AGGREGATE SAMPLE SIZES

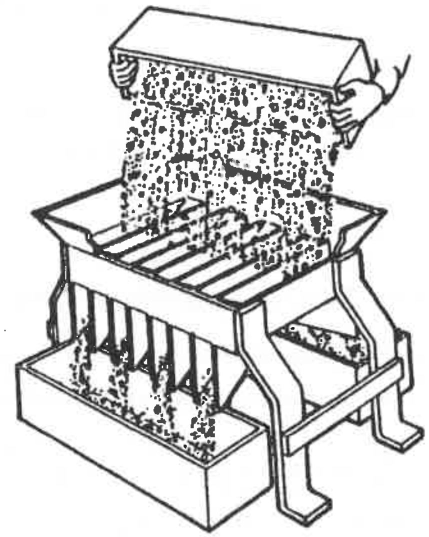
Normally, sampling procedures require that you take a larger quantity of aggregates than is actually used for testing. In this case, you must reduce the size of the sample, while still keeping it representative of the total material. You should do this by splitting. Splitting is an accurate method since a mechanical device is used to reduce the sample size.

A riffle-type sample splitter is shown below. The chutes alternate in direction. An even flow of material across the overall width of the chutes is divided between the two receiving pans.



SAMPLE SPLITTER

The sample should not be poured directly onto the splitter. You should spread the material evenly in a sample pan that comes with the splitter. The pan is the same width as the input hopper and can be tilted to unload the material uniformly, as shown below:



Be sure that you don't try to split aggregate samples whose particles are too big for the splitter being used. **The chute openings have to be at least 50% larger than the largest particles in the sample.**

After splitting, the two receiving pans contain approximately the same amounts of material. Discard the material in one pan or, if required, send it to the Laboratory. Using the contents of the other pan, continue the splitting procedure until a sample of the desired size is obtained.

SUBMITTING SAMPLES TO THE LABORATORY

When submitting aggregate samples to the Central or District Laboratory for tests that they perform, you must attach Sample Transmittal Cards (Form 675-050-04) to the sample containers.

SAMPLE CARD - AGGREGATE SAMPLE

Study the card below which has been completed for an aggregate sample. Most of the card is self-explanatory.

STATE OF FLORIDA DEPARTMENT OF TRANSPORTATION

675-050-04
MATERIALS
06/02

PROJECT 111111-1-52-01 PAY ITEM

MATERIAL NO. SAMPLE NO. DATE SAMPLED

STA FROM STA TO SAMP FROM

RDWY OFFSET DISTANCE OFFSET DIRECTION MAINLINE

REFERENCE SOURCE

PLANT OR PIT NO. QUANT REP. 22,000 gallons

INTENDED USE INSP ID

ROAD DISTRICT COUNTY CONTRACT

MATERIAL

MANUFACTURER DESIGN MIX

GRADE BATCH NO. LOT NO. LAB NO.

CONTROL OF CONCRETE

MATERIAL NO. P/F TEST BY CODE TESTER ID

DEL TICKET NO. LOAD %AIR SLUMP CONC TEMP W/C RATIO

REMARKS For coarse SP 12.5 Recycle TL-D
Blend 15-30-40-15
Samples: 4 @ 4600, 12 @ 1050 g, 1 Bag of RAP
Asphalt: PG62with 0.5% Antistrip, R-US 50-00 Antistrip Agent (D-000)

CONTACT Tom Sawyer PHONE (352) 372-5304

ADDRESS 2006 NE Waldo Road, Gainesville, FL 32605

It is necessary that you assign a sample number to <u>every</u> sample submitted. The "A" in the sample number column indicates a job sample and "I" indicates independent assurance progress record (see the Sampling, Testing and Reporting Guide to obtain the correct sample level). Keep an accurate log of the numbers so that you can refer to samples by specific numbers in case it is necessary to correspond with the Laboratory concerning them.

SAMPLE CARD - ASPHALT CEMENT SAMPLE

The card below is completed for a sample of asphalt cement. Note that a GRADE number is required for both asphalt cement and coarse aggregate samples.

STATE OF FLORIDA DEPARTMENT OF TRANSPORTATION — 675-050-04 MATERIALS 06/02

PROJECT 123456-1-52-01 PAY ITEM 1 5 3 3 1 | 7 2 | 1 0

MATERIAL NO. 4 4 5 A SAMPLE NO. A 0 0 0 2 DATE SAMPLED

STA FROM NA STA TO NA SAMP FROM NA

RDWY OFFSET DISTANCE OFFSET DIRECTION MAINLINE

REFERENCE N A SOURCE

PLANT OR PIT NO. QUANT REP. 45,000 GA

INTENDED USE INSP ID

ROAD 581 DISTRICT 01 COUNTY Pasco CONTRACT 12345

MATERIAL Asphalt Cement

MANUFACTURER Amoco Oil Co. DESIGN MIX 00-134

GRADE PG 64-22 BATCH NO. LOT NO. LAB NO.

CONTROL OF CONCRETE

MATERIAL NO. P/F TEST BY CODE TESTER ID

DEL TICKET NO. LOAD %AIR SLUMP CONC TEMP W/C RATIO

REMARKS

CONTACT Huckelberry Finn PHONE (123) 456-7890

ADDRESS 50th and Fowler, Tampa, FL

Any special pertinent information not already given on the card should be written under REMARKS. Here you **must include** the mix design number to relate the material to the design mix for which it is being tested.

As you probably noticed, since the Sample Transmittal Cards are for all materials, some blanks do not pertain to aggregates and asphalt cement. Simply leave these blanks empty. You should send samples to the Laboratory by the least expensive means possible that will ensure timely delivery -- whether it be by parcel post, bus, truck or whatever. In some cases, hand delivery of samples is possible.

QUIZ

Answer the questions at the bottom of the page based on the Sample Transmittal Card shown below:

STATE OF FLORIDA DEPARTMENT OF TRANSPORTATION

675-050-04
MATERIALS
05/02

PROJECT 123456-1-52-01 PAY ITEM 1 5 3 3 1 7 2 1 0
MATERIAL NO. 4 4 5 A SAMPLE NO. A 0 0 1 2 DATE SAMPLED 0 7 0 3 0 0
STA FROM NA STA TO NA SAMP FROM NA
RDWY OFFSET DISTANCE OFFSET DIRECTION MAINLINE
REFERENCE N A SOURCE
PLANT OR PIT NO. QUANT REP.
INTENDED USE INSP ID
ROAD 581 DISTRICT 01 COUNTY Pasco CONTRACT 12345
MATERIAL Asphalt Cement
MANUFACTURER Amoco Oil Co. DESIGN MIX 98-102
GRADE PG 76-22 BATCH NO. LOT NO. LAB NO.

CONTROL OF CONCRETE

MATERIAL NO. P/F TEST BY CODE TESTER ID
DEL TICKET NO. LOAD %AIR SLUMP CONC TEMP W/C RATIO
REMARKS

CONTACT Huckelberry Finn PHONE (123) 456-7890
ADDRESS 50th and Fowler, Tampa, FL

1. What material and grade are represented by this sample? ______________________

2. What is the sample number? ______________

3. What quantity of the material is represented by the sample? ______________________

4. The material represented by this sample is related to Laboratory Design Mix number ______________.

Check your answers on page 4-32, if you got the right answers, continue - if not go back over the material.

SAMPLING HOT MIX ASPHALT

Just like other sampling procedures, the procedures for sampling hot mix asphalt are designed to help you get representative samples. You will need a shovel, gloves, and a bucket.

The requirements for sampling hot mix asphalt are described in FM1-T 168, Sampling Bituminous Paving Mixtures.

The equipment should be clean, of course. Dirty equipment results in a poor sample -- and a poor sample results in a poor test. Good, reliable tests are an extremely important part of your job. So you must use clean sampling equipment.

You must obtain an overall sample of freshly discharged hot mix asphalt of sufficient size to provide the required number of composite samples. The sample should be removed from the haul truck immediately after the truck completes loading and moves to an accessible position. The samples are used to prepare gyratory compacted samples, to determine the asphalt content by ignition method, for determining the aggregate gradation of the extracted asphalt hot mix or for determining the maximum specific gravity of the mix.

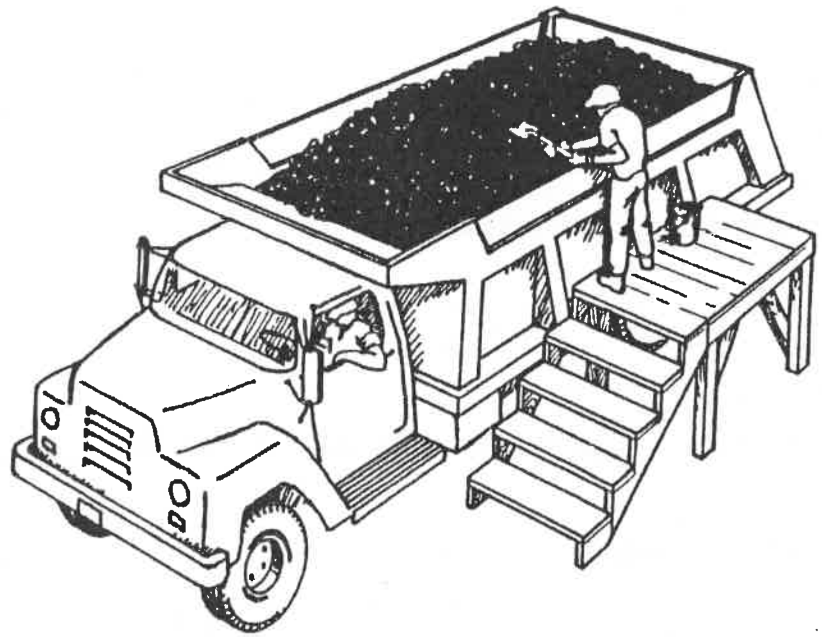
The composite sample of approximately 35 pounds should consist of at least three subsamples -- in order to obtain a representative sample.

Obtain the samples by following these procedures:

1. Using a shovel, scrape away some of the mix until you have a fairly flat sampling area approximately 12 inches below the surface.

2. Now remove a shovelful of material and place it in the bucket.

3. Repeat steps 1 and 2 in at least two other locations of the load. The sample should be taken from the front, middle and back third points of the truck. The sample should **not** be taken along the edge of the truck bed. The location should be at least 1.5 feet from the edge. If the shovel is bumped and some of the mix spills - a new sample should be taken.



NOTE: Gloves should be worn when taking or handling the samples -- **the mix is hot.**

QUIZ

1. List the equipment for obtaining hot mix samples:

   a. ________________________________

   b. ________________________________

   c. ________________________________

2. You should be sure that the items of equipment in Question 1, above, are ______________ before obtaining samples with them.

3. How much should a composite sample of hot mix weigh? ______________

4. What should be the minimum number of subsamples making up each overall sample? _______

Check your answers on page 4 - 32, if you got the right answers, continue - if not go back over the previous material.

Go on to **REDUCING HOT MIX SAMPLES.**

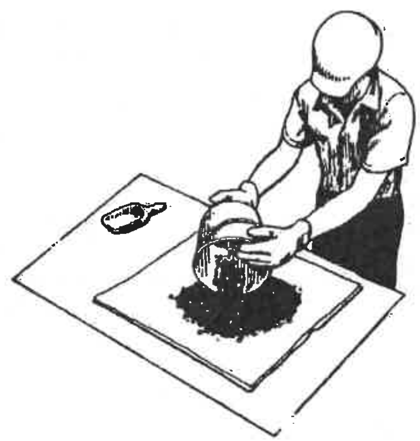
REDUCING HOT MIX ASPHALT SAMPLES

Like aggregate samples, hot mix asphalt samples must be reduced to the appropriate sizes for testing. The approximate sample sizes needed for the extraction test by the Ignition Method on a few common types of hot mix are shown here:

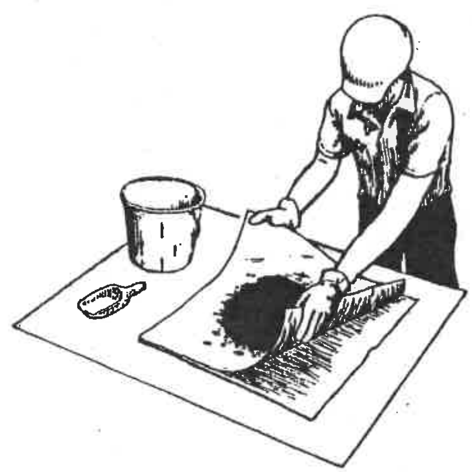
<table>
<tr><th colspan="2">IGNITION METHOD</th></tr>
<tr><th>Mix Type</th><th>Min. Sample Size</th></tr>
<tr><td>SP-19.0</td><td rowspan="2">2,000 g</td></tr>
<tr><td>SP-12.5</td></tr>
<tr><td>SP - 9.5</td><td rowspan="2">1,500 g</td></tr>
<tr><td>FC-5 & FC-6</td></tr>
</table>

Hot mix samples are reduced by the scooping and quartering method, according to the following steps:

1. Carry the hot sample to field lab and empty onto paper on table.

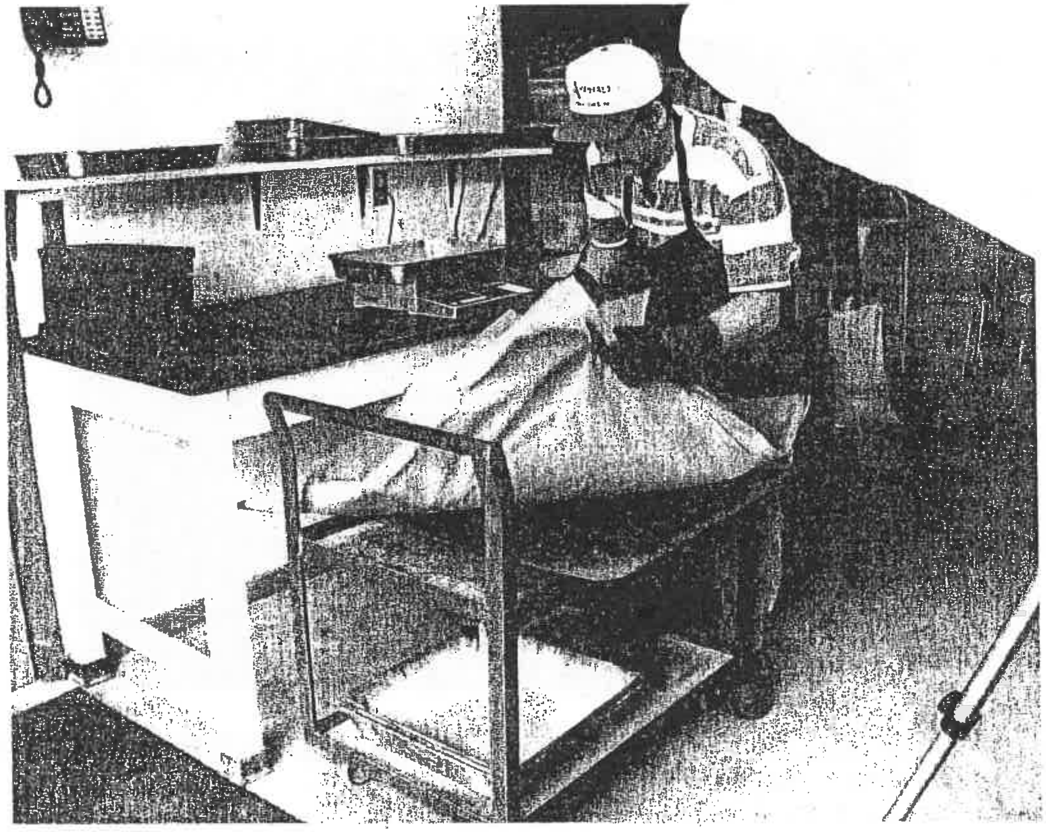


2. Now, lift the edges of the paper -- rolling the mix into a round, uniform pile in the center of the paper.



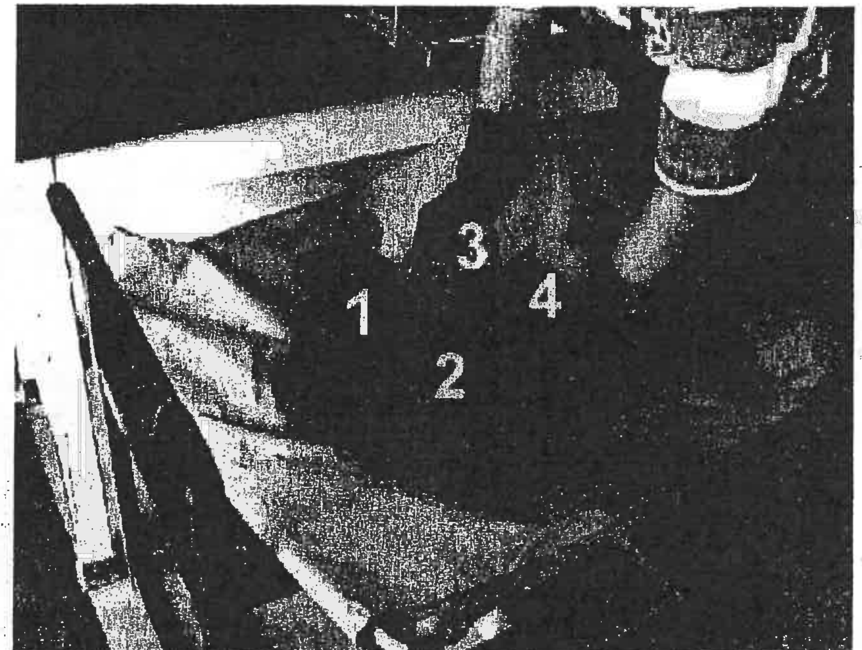
3. Once the material is uniformly mixed, samples for preparing two gyratory pills are taken by using a rounded scoop and shoving it through the center of the pile. Several scoops will be needed to obtain the required sample size. Scoop straight through the center of the mix for the first gyratory specimen. (Keep scoop on paper) Remix (roll) and scoop again for the second gyratory specimen. The gyratory specimen is a sample manufactured using the gyratory compactor (it weighs about 4,800 g and is about 150 mm in diameter and about 115 mm high).

4. After the material for the gyratory pills has been taken, the material should be remixed (rolling the mix).



5. Use a quartering device to then divide the sample into four equal portions. (A quartering bar also may be used.)

6. Alternately scoop from quarters 1 and 4 until enough mix is collected for maximum specific gravity testing. Use the material in the 2nd and 3rd quarter for ignition (extraction) testing.



7. Combine the remaining two quarters of the sample by lifting the edges of the quartering paper and forming the mix into a round uniform pile. Then quarter this pile.

8. Place two opposite quarters of the sample into one sample box and the other two quarters in an other sample box. If a referee analysis is needed, one sample is sent to the State Materials Office and one to the District Materials Office.

Go on to the quiz on the next page.

QUIZ

1. What should be the approximate sample size for testing asphalt concrete from the haul truck? ____________

2. What method is used to reduce hot mix samples to the proper quantities for testing? ____________
____

3. How do you work the sample into a round, uniform pile? ____________
____

4. Once the round, uniform pile is prepared how do you sample for gyratory pills? ____________
____

5. After sampling for the gyratory pills what do you use to divide the sample into four equal portions? ____________
____

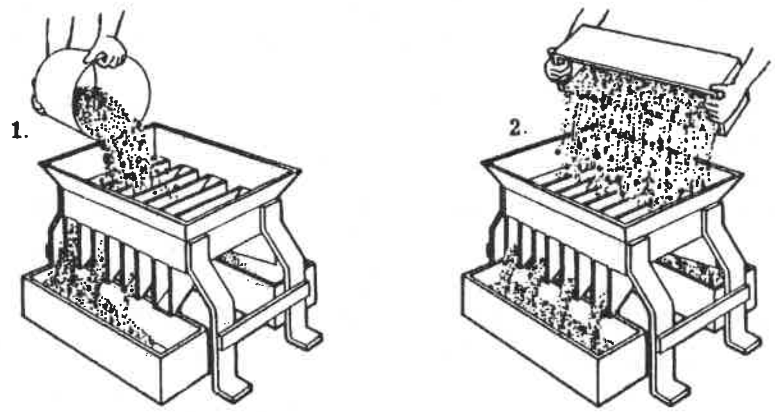
6. After quartering the sample the <u>first</u> time, what should you do with the:

   a. first two quarters? ____________
   b. remaining two quarters? ____________

7. After quartering the sample the second time, what should you do with each pair of quarters? ____________
____

8. Should the pairs of sample quarters be adjacent quarters? ____________

9. From the diagram below, which is the correct procedure for placing the aggregates in the sample splitter? ________



10. The splitting cycle is repeated, using ________ (1/4, ½, all) of the material each time, until the sample is reduced to the desired size.

11. Which of the following may properly be included in an overall description of sampling?

__ A. Combining aggregate samples from different hot bins into a composite sample.
__ B. Observing the proper methods for locating and removing samples.
__ C. Obtaining representative -- typical -- portions of the proper sizes.
__ D. Handling samples carefully to avoid contaminating them, changing their properties or losing material.

12. Describe the proper container for samples of asphalt cement. ____________________

13. What should you do with certification papers that accompany loads of liquid bituminous material?____________
____

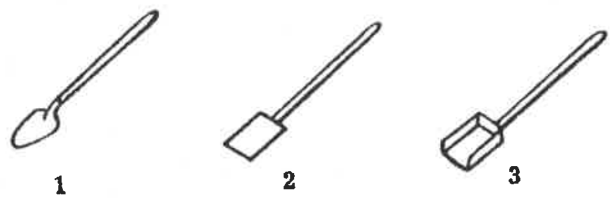
14. Which of the following describes a proper procedure in aggregate sampling of stockpiles?

__ A. Obtain samples in vertical line at three levels of stockpile.
__ B. Remove slope aggregates first, then sample from flat area.
__ C. Sample from three stockpile levels at staggered locations around the pile.
__ D. Sample only from the aggregates deposited around the base of the stockpile.

15. When sampling from a railroad car, how many locations should you sample from along the bottom of each trench?

____

16. The best sampling device is shown in figure ________, below.



17. Describe the best device for sampling from hot bins: ____

18. How much material should you remove from each hot bin in relation to the amount needed for testing? __________
____

19. Before drawing off a sample of asphalt cement from the spigot, you should draw off and discard about __________ ________ of the material. This will ensure that your sample is ____________________.

20. What identifying tag should accompany every sample submitted to the Central or District Laboratory?

____

Check your answers on page 4-33, if you got the right answers, "Congratulations" - if not go back over the material.

ANSWERS TO QUESTIONS

Page 4-4
1. A, B, D
2. C
3. sampling devices (spigots)
4. A, C, D
5. A. 2
   B. 3
   C. 1
6. Sample Transmittal Cards

Page 4-7
1. Yes
2. one gallon
3. After the test sample
4. No
5. Immediately
6. Clean, dry cloth
7. Sample transmittal card
8. Retain them as backups for original sample.
9. Submit to project office

Page 4-10
1. A, B
2. segregation
3. A, D
4. Square-point shovel and a clean, flat board

Page 4-14
1. one foot, one foot
2. B, D, E
3. Directly against the sides of the car, truck or vessel
4. 1-1/4 inch diameters, 6-foot lengths
5. Sample divider
6. Yes
7. 12 in long, 12 in wide, & 4 inch
8. Three or four times the amount
9. A

Page 4-21
1. Asphalt cement
   PG 76-22
2. A-0012
3. 22,000 gallons
4. 98-102

Page 4-24
1. a. shovel
   b. bucket
   c. gloves
2. clean
3. sufficient size to provide the required number of samples
4. 3

Page 4-29

1. 35 lbs
2. Scooping and quartering
3. Rolling mix by lifting the edges of the paper.
4. by scooping until the sample is obtained
5. quartering device
6. a. Rice samples
   b. Ignition testing
7. one sample for the District lab and one sample for the SMO lab if needed
8. No
9. 2
10. ½
11. B, C, D
12. 1 quart friction-top cans
13. Collect and submit with daily reports to project office
14. B, C
15. Seven
16. 3
17. Metal box - 12" long, 12" wide and 4" deep
18. Three or four times the amount
19. one gallon, representative
20. sample transmittal card

PERFORMING A GRADATION ANALYSIS

In this chapter we will discuss the test procedures for performing a gradation analysis of coarse aggregate, fine aggregate, and mineral filler used in hot mix asphalt. We also will cover the calculation and documentation of test results.

Before discussing the actual test procedures, we will discuss gradation requirements, sieve sizes, the field laboratory and test equipment. We will start with gradation requirements.

GRADATION REQUIREMENTS

Aggregate gradation requirements tell you the percentages of aggregates (by weight) that must pass each specified sieve size. Under FDOT asphalt specifications, <u>all</u> gradation requirements are based on percentages <u>passing</u>.

ASPHALT CONCRETE MIXES

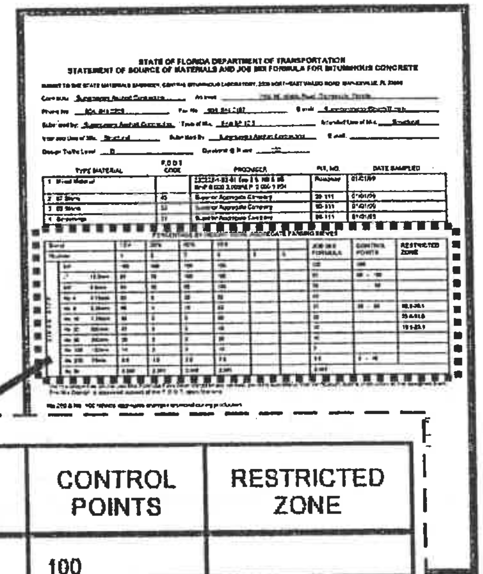
Gradation requirements for asphalt concrete mixes are set forth in the Standard Specifications and in the mix design. The Standard Specifications show the design ranges of percentages for all aggregates (including mineral filler) and the mix design gives the specific requirements for the particular mix.

AGGREGATE COMPONENTS

The specific gradation requirements for individual aggregates used in bituminous mixtures are included in the Standard Specifications. The aggregate components must meet these requirements and must be capable of being blended to meet mix design requirements.

A page from a Mix Design is shown on the next page. The chart at the bottom shows the gradation requirements for both the individual components and for the combined aggregate gradation.

If graded, samples of the planned combination of coarse and fine aggregates would comply with the limits of the specification design range shown here.


STATE OF FLORIDA DEPARTMENT OF TRANSPORTATION
STATEMENT OF SOURCE OF MATERIALS AND JOB MIX FORMULA FOR BITUMINOUS CONCRETE

PERCENTAGE BY WEIGHT TOTAL AGGREGATE PASSING SIEVES

Blend		15%	30%	40%	15%			JOB MIX FORMULA	CONTROL POINTS	RESTRICTED ZONE
Number		1	2	3	4	5	6			
SIEVE SIZE	3/4"	100	100	100	100			100	100	
	½" 12.5mm	97	70	100	100			91	90 - 100	
	3/8" 9.5mm	94	38	95	100			79	- 90	
	No. 4 4.75mm	83	5	38	92			43		
	No. 8 2.36mm	66	4	19	82			31	28 - 58	39.1-39.1
	No. 16 1.18mm	58	3	5	69			22		25.6-31.6
	No. 30 600um	47	3	5	48			17		19.1-23.1
	No. 50 300um	28	2	3	28			10		
	No. 100 150um	14	2	3	18			7		
	No. 200 75um	8.0	1.0	2.0	7.0			5.0	2 - 10	
	Sp. Gr.	2.562	2.393	2.448	2.581			2.467		

QUIZ

1. In what two places can you find gradation requirements for the aggregates used in asphalt concrete? ____________ ____________________________ and ________________________.

2. Under FDOT asphalt specifications, aggregate gradation requirements tell you the percentages of aggregates that must ____.

3. The percentages of aggregates are based on the _______________ of the aggregates.

Check your answers on page 5-39, if you got the right answers, continue - if not go back over the material.

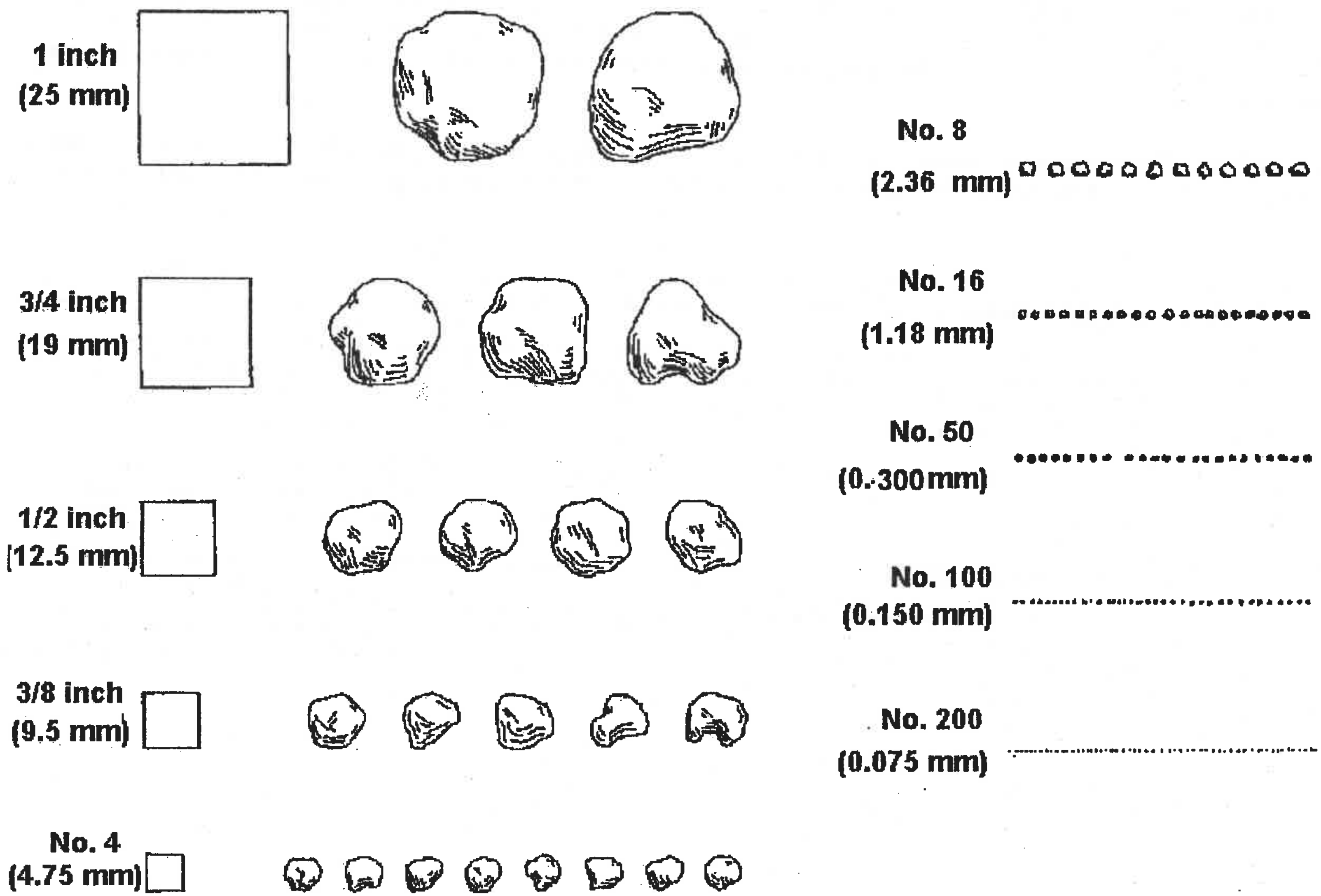
SIEVE SIZES

Standard sieve sizes are designated in millimeters. However, the common alternate designations for sieve openings are inches and openings per inch. The Department has issued a chart that shows the standard and alternate sieve designations, their nominal sieve openings, and the tolerances for variation from the designations. Part of the chart is shown below. Study it.

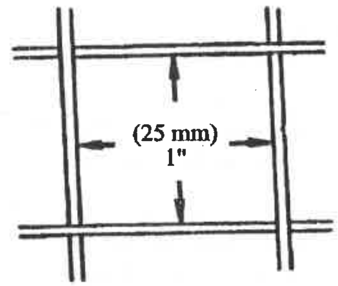
As a Technician, you should be familiar with the standard sieve designations and their alternates. Occasional inspections will be made by Department personnel to determine whether or not the nominal sieve openings are within the tolerance ranges.

In this course, however, we will use the standard millimeter (mm) designations. Various sieve sizes and the relative size of the aggregates that are retained on each sieve are shown on the following page.

Sieve Designation		Nominal Sieve Openings		AASHTO M 9270	Tolerance Range	
Standard (mm)	Alternate	mm	inches	Tolerance (mm)	mm	inches
9.5	3/8	9.5	0.375	± 0.30	9.20 - 9.80	0.362 - 0.386
6.3	1/4	6.3	0.250	± 0.20	---	----
4.75	No. 4	4.75	0.187	± 0.15	4.60 - 4.90	0.181 - 0193
2.36	No. 8	2.36	0.0937	± 0.0937	2.28 - 2.44	0.0897-0.0961


1 inch
(25 mm)
3/4 inch
(19 mm)
1/2 inch
(12.5 mm)
3/8 inch
(9.5 mm)
No. 4
(4.75 mm)
No. 8
(2.36 mm)
No. 16
(1.18 mm)
No. 50
(0.300 mm)
No. 100
(0.150 mm)
No. 200
(0.075 mm)

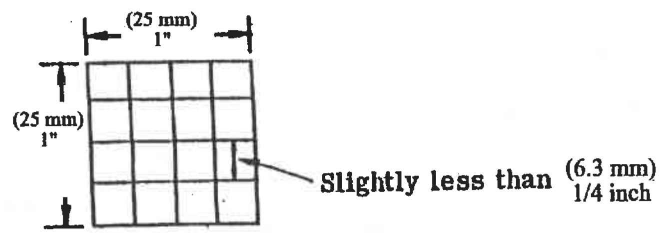
The 1 - inch (25.0 mm) sieve has clear openings 1-inch (25.0 mm) square. When we say "clear" openings, we mean the actual space between the wires of the sieve mesh. Look at the diagram below:



The openings in sieves classified in inches (mm) are exactly the size indicated. In other words, a 1-inch (25.0 mm) sieve has openings 1 inch square.

An alternate designation of U.S. standard sieves are sieve numbers. Sieve numbers do not exist in standard reference of sieves because the "clear" openings are used even for finer openings. However, for alternate reference, a No. 4 sieve is sometimes used instead of a 1/4 inch sieve. Sieve numbers are often used for sieve sizes less than 1/4 inch "clear" openings.

A No. 4 (4.75 mm) sieve is slightly finer than a 1/4-inch sieve, because of the width of the wire mesh. Refer again to the chart on page 5-5 to note the actual difference in the nominal sieve openings between a 1/4-inch sieve and a No. 4 (4.75 mm) sieve. A one-square-inch (one-square 25 mm) section of No. 4 (4.75 mm) sieve looks like this:



A No. 8 (2.36 mm) sieve has 8 openings per linear inch (per linear 25 mm).

The No. 100 (150 μm) sieve is four times as fine as the No. 50 (300 μm). The No. 200 (75 μm) sieve is so fine that it looks like silk. Dust from the aggregate particles is the only material that will pass the No. 200 (75 μm) sieve.

In laboratory tests and for the purposes of proportioning paving mixtures, the dividing line between coarse and fine aggregates is the No. 8 (2.36 mm) sieve. In other words, all aggregates that would be retained on a No. 8 (2.36 mm) sieve can be considered coarse. Likewise, all aggregates that would pass a No. 8 (2.36 mm) sieve can be considered fine. Aggregates too coarse to pass a particular sieve are termed "plus" material, while aggregates that pass the sieve are termed "minus" material. Plus means coarser than; minus means finer than. For example, aggregates coarser than a 3/4-inch (19.0 mm) sieve are called plus 3/4-inch (19.0 mm) material. Aggregates finer than a 3/4-inch (19.0 mm) sieve are called minus 3/4-inch (19.0 mm) material and so on.

To be retained on any sieve, the aggregates must be coarser than the mesh openings in every direction, as the aggregates will be shaken thoroughly over the screens.

QUIZ

1. Standard sieve sizes are designated in ________________.

2. Is minus ½-inch (12.5 mm) material finer than the openings in a ½-inch (12.5 mm) sieve? __________

3. When the sieves are used in combination, material retained on the ½-inch (12.5 mm) sieve is coarser than ________ ________ inch (mm) in every dimension, but finer than _______________ inch (mm) in at least one dimension.

4. All plus No. 8 (+2.36 mm) material can be considered _______________.

5. Plus 3/8-inch (9.5 mm) material is any aggregate material retained on a _______________ inch (mm) sieve.

6. How many openings are in one square inch of a No. 4 (4.75 mm) sieve? ________

7. Each opening of a No. 4 (4.75 mm) sieve is slightly smaller than _______________ inch (mm), because of the width of the mesh.

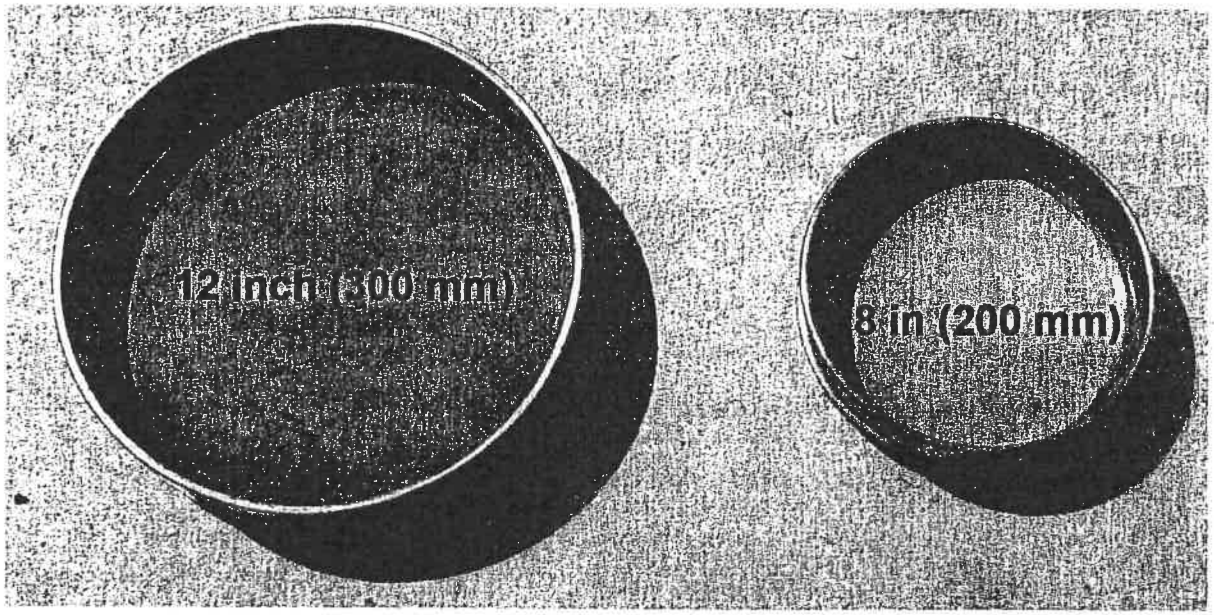
8. A No. 8 (2.36 mm) sieve has ________ openings in one <u>square</u> inch.

9. A No. 50 (300 μm) sieve has ________ openings in one <u>linear</u> inch.

Check your answers on page 5-39, if you got the right answers, continue - if not go back over the material.

TYPES OF SIEVES

The gradation of aggregate samples is tested on 12-inch (300 mm) or 8-inch (200 mm) round brass sieves. The 12-inch (300 mm) round sieves are used for sieving all fine aggregates, the hot bin samples, and the aggregates from the extraction tests.



The sieve sizes to be used in gradation tests depend on the specifications covering the material to be tested. You must select the sizes that will determine the gradation of the sample according to the specification sizes.

QUIZ

1. The two types of sieves used in gradation analyses are ________________ and ________________ round sieves.

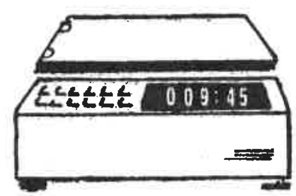
2. What governs the sizes of sieves that you use in gradation tests? ____________________________________
____

Check your answers on page 5-39, if you got the right answers, continue on to **TEST PROCEDURES** - if not go back over the previous material.

WEIGHING THE SAMPLE

When you have dried the sample sufficiently, weigh it. All weights, of course, exclude the weights of the weighing pans. So, before you begin, balance (zero) the scale with the weighing pan on it. Use a scale with an adequate capacity to weigh the entire sample.

PLATFORM SCALE



You may see other types of scales for coarse and fine aggregates; but whatever type is used, they must be capable of weighing the samples to within 0.1% per AASHTO M231-9 of the sample weights.

Here are some more important points: Be sure that the weighing pans are clean -- with no dust or other foreign matter which would affect the gradation tests. When transferring samples from one container into another, be sure to transfer all of the materials. It is a good idea to use an overflow pan to catch any aggregates that may spill during the transfer. Also, fine aggregates tend to stick to the sides of the containers -- so use a screen brush to brush them loose.

Accuracy is required when weighing test samples. Stockpile samples of coarse aggregate should be weighed to the nearest 0.01 lb on a platform scale. Fine aggregate samples, bin samples, and extracted aggregates should be weighed to the nearest 0.1 g on the gram scale.

Once you have determined the exact weight of the test sample -- according to the above accuracy requirements -- write the weight on a worksheet.

Go on to the quiz.

QUIZ

1. The nominal maximum particle size of the aggregates you have just sampled is 3/4 inch (19.0 mm). What minimum sample weight should you use for testing?
   ________ pounds (________ kilograms)

2. What approximate size test sample should you use when about 92% of the fine aggregates have been passing a No. 4 (4.75 mm) sieve and about 8% have been retained on a No. 8 (2.36 mm) sieve? ____________________

3. Aggregates should be dried to a constant weight in an oven capable of maintaining:

   __ A. a temperature of over 300°F.
   __ B. a uniform temperature.
   __ C. a temperature of 230 ± 9°F.

4. A constant weight is obtained when ________ weighings, at intervals, give the same result.

5. Fine aggregate samples, bin samples, and extracted aggregates should be weighed on ____________________.

6. Does the weight of the sample include the weight of the sample container? ________

7. All scales must be capable of weighing aggregate samples to within ________ of the sample weights.

Check your answers on page 5-39, if you got the right answers, continue - if not go back over the material.

SIEVING AND WEIGHING COARSE AGGREGATES

Let's first run a gradation test on a sample of coarse aggregates. The same procedure should be followed for coarse aggregate samples from any of the methods of shipment discussed in Chapter Three and from conveyor belts and cold bins. If the coarse aggregate is excessively dirty it may need to be washed and dried before it is tested. If this is the case, see the next section on fine aggregate washing and follow the procedure.

Using sieves of the required sizes, stack the sieves according to size -- coarsest sieve on top. We will say that the required sizes are those shown in the table below. Use a pan to catch the minus No. 200 (75 μm) material. In some cases, when the test samples are quite large, the samples may need to be sieved in two or three parts -- to avoid overloading the sieves. At all times be careful not to lose <u>any</u> material.

When the sample is thoroughly sieved, you are ready to do some more weighing. Place all aggregates retained on the largest sieve in the weighing pan and weigh it to the nearest <u>tenth of a gram (0.1 g)</u>. Now record the weight of the material retained on the 3/4-inch (19.0 mm) sieve as shown below -- the entry is 0.0 since no material was retained.

ORIGINAL DRY WEIGHT 2200.1 g

TYPE MATERIAL Grade 67 aggregate

SAMPLE NUMBER 1

SIEVE		CUMULATIVE WEIGHT [gm]	TOTAL % RETAINED	TOTAL % PASSING
19.0 mm	(3/4)	0.0		
12.5 mm	(1/2)	177.0		
9.5 mm	(3/8)			
4.75 mm	(4)			
2.36 mm	(8)			
2.36 mm	(16)			
600 μm	(30)			
300 μm	(50)			
150 μm	(100)			
75 μm	(200)			
PAN				

Now place the plus 1/2-inch (12.5 mm) material in the weighing pan. If 177.0 g are retained on the 1/2-inch (12.5 mm) sieve, record the CUMULATIVE WEIGHT as shown above.

Cumulative weight = 177.0 g + 0.0 g = 177.0 g

Then weigh the plus 3/8-inch (9.5 mm) material by placing it in the weighing pan with the other material. Record the CUMULATIVE WEIGHT -- 508.1 g -- in the same way. Continue this process until you have weighed the material on each sieve.

ORIGINAL DRY WEIGHT 2200.1 g

TYPE MATERIAL Grade 67 aggregate

SAMPLE NUMBER 1

SIEVE		CUMULATIVE WEIGHT [gm]	TOTAL % RETAINED	TOTAL % PASSING
19.0 mm	(3/4)	0.0		
12.5 mm	(1/2)	177.0		
9.5 mm	(3/8)	508.1		
4.75 mm	(4)	1112.3		
2.36 mm	(8)	1326.4		
1.18 mm	(16)	1502.7		
600 μm	(30)	1625.4		
300 μm	(50)	1718.9		
150 μm	(100)	1856.3		
75 μm	(200)	1975.2		
PAN		2200.1		

Finally, place the material retained in the PAN into the weighing pan along with the other material. Then reweigh the material to get the CUMULATIVE WEIGHT retained in the PAN -- and record the CUMULATIVE WEIGHT.

The CUMULATIVE WEIGHT retained in the PAN should always be the same as the ORIGINAL DRY WEIGHT of the sample, as shown at the top of the worksheet (within 0.2% of the original weight). If they are not the same, you will know that you made a mistake -- you may have lost some of the aggregates during the test or you may have made a mistake in weighing. In any case, if the CUMULATIVE WEIGHT retained in the PAN is significantly different from the ORIGINAL DRY WEIGHT, you probably should obtain a new sample and start from the beginning.

Now, with the CUMULATIVE WEIGHTS recorded on the worksheet, we are ready to calculate the total percentages retained and passing.

To calculate the TOTAL % RETAINED divide the CUMULATIVE WEIGHT by the ORIGINAL DRY WEIGHT. For example, divide the 177.0 g retained on the 1/2-inch (12.5 mm) sieve by the ORIGINAL DRY WEIGHT.

177.0 g ÷ 2200.1 g = 0.080 or 8%

This means that 8% of this sample was retained on the 1/2-inch (12.5 mm) sieve.

From here it's a simple calculation to determine TOTAL % PASSING. Just subtract 8% from 100% -- 92%. So, 92% of the total sample passed the 1/2-inch (12.5 mm) sieve.

Repeat these calculations for each of the other sieves. Always subtract the cumulative % retained from 100%. Always round off the percentages to the nearest whole percent, except for the -200 fraction, which is rounded to tenths. For our example, the worksheet will look like the one below.

ORIGINAL DRY WEIGHT: 2200.1 g

TYPE MATERIAL: Grade 67 aggregate

SAMPLE NUMBER: 1

SIEVE		CUMULATIVE WEIGHT [gm]	TOTAL % RETAINED	TOTAL % PASSING
19.0 mm	(3/4)	0.0	0	100
12.5 mm	(1/2)	177.0	8	92
9.5 mm	(3/8)	508.1	23	77
4.75 mm	(4)	1112.3	51	49
2.36 mm	(8)	1326.4	60	40
1.18 mm	(16)	1502.7	68	32
600 μm	(30)	1625.4	74	26
300 μm	(50)	1718.9	78	22
150 μm	(100)	1856.3	84	16
75 μm	(200)	1975.2	89.7	10.3
PAN		2200.1	100	0

After the quiz beginning on the next page we will discuss testing a fine aggregate sample.

Example Problem

Using the information below, complete the gradation worksheet on this page. Then compare your calculations with the answers on the next page.

Question 1 - You are testing sample no. 2 from a stockpile. The test sample weighs 2372.1 g. Nothing is retained on the 3/4-inch (19.0 mm) sieve. On the 1/2-inch (12.5 mm) sieve, 122.1 g of dry aggregate is retained and the rest of the cumulative weights are 494.3, 1529.4, 1769.6, 1935.8, 2100.5, 2215.6, 2272.1, 2350.3 and 2372.1 grams.

ORIGINAL DRY WEIGHT ______________________

TYPE MATERIAL ______________________

SAMPLE NUMBER ______________________

SIEVE	CUMULATIVE WEIGHT [gm]	TOTAL % RETAINED	TOTAL % PASSING
19.0 mm (3/4)			
12.5 mm (1/2)			
9.5 mm (3/8)			
4.75 mm (4)			
2.36 mm (8)			
1.18 mm (16)			
600 μm (30)			
300 μm (50)			
150 μm (100)			
75 μm (200)			
PAN			

Solution - Example Problem

The answers to the gradation test are shown below:

ORIGINAL DRY WEIGHT 2372.1 g

TYPE MATERIAL Grade 67 aggregate

SAMPLE NUMBER 2

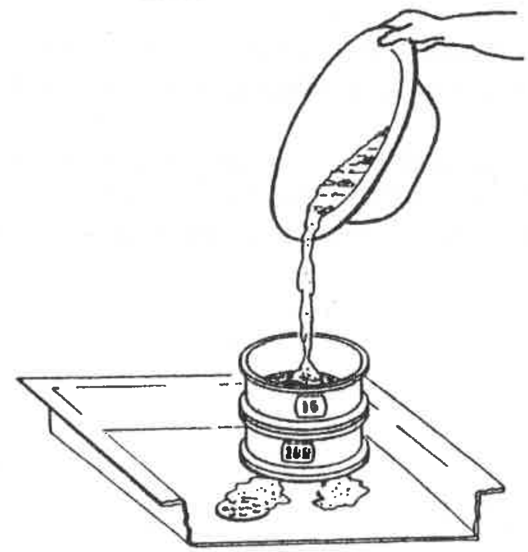
SIEVE		CUMULATIVE WEIGHT [gm]	TOTAL % RETAINED	TOTAL % PASSING
19.0 mm	(3/4)	0.0	0	100
12.5 mm	(1/2)	122.1	5	95
9.5 mm	(3/8)	494.3	21	79
4.75 mm	(4)	1529.4	64	36
2.36 mm	(8)	1769.6	75	25
1.18 mm	(16)	1935.8	82	18
500 μm	(30)	2100.5	89	11
300 μm	(50)	2215.6	93	7
150 μm	(100)	2272.1	96	4
75 μm	(200)	2350.3	99.1	0.9
PAN		2372.1	100	0.0

How did you do? If you had some trouble in the test calculations, review pages 5-17 through 5-23 now. Do not continue until you understand these procedures and computations. When you are ready, go on to WASHING, SIEVING AND WEIGHING FINE AGGREGATES.

WASHING, SIEVING, AND WEIGHING FINE AGGREGATES

Now we will discuss the test procedures for a fine aggregate sample. We will determine the gradations based on percentages retained -- for your general information. However, under FDOT asphalt specifications, the requirements are based on the percentages passing. The main difference between this procedure and the procedure for testing a coarse aggregate sample is that the fine aggregate sample must be washed before it is sieved.

Why must fine aggregates be washed before being sieved? Well, when fine aggregates are sieved, some of the very fine particles tend to cling to the coarser particles. For this reason, when testing samples of fine aggregates, you have to use a combination of washing and dry sieving to determine the total amount of material finer than the No. 200 sieve (75 μm).



Before washing the fine aggregate sample, dry it to a constant weight and record this weight on the worksheet. Now you are ready to wash the sample.

You need a mixing bowl large enough to hold the fine aggregate sample covered with water and with sides high enough to permit vigorous agitation of the sample without any loss. Place the sample in the bowl. Then cover the sample with water and add an approved detergent. For hard water, you may need to add a water softener. Detergent helps separate the fines in the aggregates. Mix the sample well with your hands. It may be necessary to soak some samples for 5 minutes in order to help separate the fines.

Next, place a No. 8 (2.36 mm) sieve over a No. 200 (75 μm) sieve. The No. 8 (2.36 mm) sieve "protects" the No. 200 (75 μm) sieve from being damaged by larger particles. Then, stir and agitate the sample with your hands. Be sure that no particles cling to your hands. Immediately pour off as much water as possible, over the nested sieves, without pouring off the corner particles. The pouring process is called "decanting."

Repeat the procedure of covering with water, agitating, and decanting until the wash water runs clear. Clear wash water indicates that all minus 200 (75 μm) material has been removed.

Pour the material retained on the sieves back into the bowl. Wash the No. 200 (75 μm) sieve with a little water, if necessary, to be sure that all retained aggregates are recovered. Dry the aggregates to a constant weight, as discussed earlier. The difference between the washed weight and the original weight is the weight of the minus 200 (75 μm) material. Let's say the ORIGINAL DRY WEIGHT was 426.4 g, and that the washed-and-dried weight was 418.4 g. The difference -- 8.0 g -- is the minus 200 (75 μm) material that was washed from the aggregate. Record these weights at the top of the worksheet, as shown on the next page.

Now, take the dried plus 200 (75 μm) aggregates, place them in the stack of sieves and run the gradation test. Record the cumulative weights. Let's say that our sieving yields the results shown on the next page.

Notice that some minus 200 (75 μm) material remained in the sample even after being washed. To get the total weight of the minus 200 (75 μm) material, the difference between the washed weight of the sample and its original dry weight must be added to the weight of the material passing the No. 200 (75 μm) sieve (retained in the pan).

TYPE MATERIAL: Local Sand
SAMPLE NUMBER: ______

ORIGINAL DRY WEIGHT: 426.9 g
WASHED WEIGHT: 418.4 g
DIFFERENCE: 8.0 g

SIEVE		CUMULATIVE WEIGHT (GRAMS)	TOTAL PERCENT RETAINED	TOTAL PERCENT PASSING
12.5 mm	(1/2)			
9.5 mm	(3/8)			
4.75 mm	(No. 4)	0		
2.36 mm	(No. 8)	9.7		
1.18 mm	(No. 16)	115.6		
600 μm	(No. 30)	348.7		
300 μm	(No. 50)	392.2		
150 μm	(No. 100)	417.9		
75 μm	(No. 200)	418.4		
PAN			XXXXXXXXXXXXXXX	XXXXXXXXXXXXXXX
WEIGHT IN PAN			0.5	XXXXXXXXXXXXXXX
+ DIFFERENCE			8.0	XXXXXXXXXXXXXXX
TOTAL WT OF 75 μm (-200)			8.5	

The percentages are now calculated by dividing the individual weights retained by the ORIGINAL DRY WEIGHT of the sample. For example, 9.7 g was retained between the No. 4 (4.75 mm) and No. 8 (2.36 mm) sieves:

$9.7\ g \div 426.9\ g = 0.023$ or 2% retained

100% - 2% = 98% passing

The remainder of the calculations are as for coarse aggregate, with the exception of the calculation for minus 200 (-75 μm) material. For the minus 200 (-75 μm) material, the total weight (8.5 g) is divided by the original sample weight (426.9 g) and converted to a percent.

The results are compared with the fine aggregate gradations shown on the mix design.

TYPE MATERIAL: Local Sand
SAMPLE NUMBER: ____________

ORIGINAL DRY WEIGHT: 426.4 g
WASHED WEIGHT: 418.4 g
DIFFERENCE: 8.0 g

SIEVE		CUMULATIVE WEIGHT (GRAMS)	TOTAL PERCENT RETAINED	TOTAL PERCENT PASSING
12.5 mm	(1/2)			
9.5 mm	(3/8)			
4.75 mm	(No. 4)	0	0	100
2.36 mm	(No. 8)	9.7	2	98
1.18 mm	(No. 16)	115.6	27	73
600 μm	(No. 30)	348.7	82	18
300 μm	(No. 50)	392.2	92	8
150 μm	(No. 100)	417.9	98	2
75 μm	(No. 200)	418.4	98.0	2.0
PAN			XXXXXXXXXXXXXXX	XXXXXXXXXXXXXXX
WEIGHT IN PAN			0.5	XXXXXXXXXXXXXXX
+ DIFFERENCE			8.0	XXXXXXXXXXXXXXX
TOTAL WT OF 75 μm (-200)			8.5	

Okay, now try the quiz that begins on the next page.

Example Problem

Using the information below, complete the gradation worksheet on the next page. Then compare your calculations with the answers on the following page.

You are testing a 511.0 g sample of local sand. It is your fourth sample from the stockpile. After washing and drying the sample, you find that the weight of the washed aggregate is 496.5 g. By sieving the washed sample you determine the following individual weights:

- 43.3 g between No. 4 (4.75 mm) and No. 8 (2.36 mm);
- 94.5 g between No. 8 (2.36 mm) and No. 16 (1.18 mm);
- 90.5 g between No. 16 (1.18 mm) and No. 30 (600 μm);
- 81.5 g between No. 30 (600 μm) and No. 50 (300 μm);
- 82.6 g between the No. 50 (300 μm) and the No. 100 (150 μm);
- 102.0 g between the No. 100 (150 μm) and the No. 200 (75 μm); and
- 2.1 g passing the No. 200 (75 μm) sieve.

TYPE MATERIAL: ______________________

SAMPLE NUMBER: ______________________

ORIGINAL DRY WEIGHT: __________ g

WASHED WEIGHT: __________ g

DIFFERENCE: __________ g

SIEVE		CUMULATIVE WEIGHT (GRAMS)	TOTAL PERCENT RETAINED	TOTAL PERCENT PASSING
12.5 mm	(1/2)			
9.5 mm	(3/8)			
4.75 mm	(No. 4)			
2.36 mm	(No. 8)			
1.18 mm	(No. 16)			
600 μm	(No. 30)			
300 μm	(No. 50)			
150 μm	(No. 100)			
75 μm	(No. 200)			
PAN			XXXXXXXXXXXXXXX	XXXXXXXXXXXXXXX
WEIGHT IN PAN				XXXXXXXXXXXXXXX
+ DIFFERENCE				XXXXXXXXXXXXXXX
TOTAL WT OF 75 μm	(-200)			

Solution - Example Problem

The answers to the gradation test are shown below:

TYPE MATERIAL: Local Sand
SAMPLE NUMBER: 4

ORIGINAL DRY WEIGHT: 511.0 g
WASHED WEIGHT: 496.5 g
DIFFERENCE: 14.5 g

SIEVE		CUM WEIGHT (GRAMS)	TOTAL PERCENT RETAINED	TOTAL PERCENT PASSING
12.5 mm	(1/2)			
9.5 mm	(3/8)			
4.75 mm	(No. 4)	0	0	100
2.36 mm	(No. 8)	43.3	8	92
1.18 mm	(No. 16)	137.8	27	73
600 µm	(No. 30)	228.3	45	55
300 µm	(No. 50)	309.8	61	39
150 µm	(No. 100)	392.4	77	23
75 µm	(No. 200)	494.4	96.8	3.2
PAN			XXXXXXXXXXXXXXX	XXXXXXXXXXXXXXX
WEIGHT IN PAN			2.1	XXXXXXXXXXXXXXX
+ DIFFERENCE			14.5	XXXXXXXXXXXXXXX
TOTAL WT OF 75 µm	(-200)		16.6	3.2

QUIZ

1. Why are fine aggregate samples washed?

   ___ A. To keep the sieves cleaner
   ___ B. To help determine the total amount of minus 200 (-75 µm) material
   ___ C. To rid the samples of dust
   ___ D. To make the weighing more accurate

2. Number the following steps for washing and dry sieving in the correct order:

   ___ A. Place No. 8 (2.36 mm) sieve over No. 200 (75 µm) sieve; then agitate sample again.

   ___ B. Place sample in bowl, cover with water and add detergent.

   ___ C. Dry unwashed sample to constant weight.

   ___ D. Decant the sample. Repeat previous procedure until wash water runs clear.

   ___ E. Mix sample well; then allow to soak for at least 5 minutes.

   ___ F. Return washed aggregates to bowl and dry to constant weight.

   ___ G. Determine weight of minus 200 (75 µm) material and sieve plus 200 (75 µm) aggregates.

Check your answers on page 5-39, if you got the right answers, continue - if not go back over the material.

WASHING, SIEVING, AND WEIGHING MINERAL FILLER

Like fine aggregate samples, mineral filler samples are washed before being sieved. Let's go through the requirements and procedures. First, the requirements:

Balances used in weighing mineral filler samples must be sensitive to 0.1 g. The required sieves are a No. 30, No. 80 and No. 200 (600 µm, 180 µm and 75 µm). The minimum weight of the test sample -- after being dried to a constant weight is 100 g. Weights should be recorded to the nearest 0.1 g, and percentages to the nearest 0.5%.

The gradation requirements as per specifications are shown below:

Total passing No. 30 (600 µm) sieve....................100 %
Total passing No. 80 (180 µm) sieve..............95 % (min.)
Total passing No. 200(75 µm) sieve..............65 % (min.)

Now for the procedures:

First, the sample is dried to a constant weight and the weight is recorded. Then, the sample is placed in a container and washed by a stream of water to separate the minus 200 (75 µm) material from the larger particles. Be careful not to splash any particles out of the container.

Then, immediately pour the sample and solution into a 1.18 mm (No. 16) sieve nested on a No. 200 (75 µm) sieve. Wash the sample on the sieves with the stream of water until the water flowing out at the bottom is clear. Be sure to pour <u>all</u> of the sample from the container and wash it thoroughly over the sieves.

When you finish washing the sample, return the material to the container. Dry the washed sample to a constant weight. Record this weight and determine the difference between it and the original dry weight.

Now sieve the plus 75 µm (200) material on the No. 30, No. 80 and No. 200 (600 µm, 180 µm and 75 µm) sieves. Place a pan under these nested sieves to catch any minus 75 µm (200) material that could have remained in the material after the washing.

Weigh the contents of each sieve and the pan and record these weights cumulatively. Determine the cumulative percents retained and passing -- as you learned how to do for the coarse aggregate sample.

For the cumulative pan weight, be sure to add the weight of the minus 200 (-75 μm) material washed out of the sample to any weight retained in the pan. The calculations for a test sample weighing 105 g might look like those below:

SIEVE	CUMULATIVE WT. RETAINED	TOTAL % RETAINED	TOTAL % PASSING
30 (600 μm)	0.00	0.0	100.0
80 (180 μm)	3.15	3.0	97.0
200 (75 μm)	31.20	29.5	70.5
PAN	105.00	100.00	0.0

SIEVING HOT BIN SAMPLES

The results of gradation analyses of hot bin samples are used to determine the proportions of aggregates needed from each bin to achieve a combined aggregate mixture that complies with the mix design.

You will not know for sure if the combination of aggregates in the hot mix compares favorably with the mix design until you perform a gradation test on aggregates extracted from a hot mix sample. We will discuss gradation analyses of extracted aggregates in a few pages.

QUIZ

1. Mineral filler samples are ____________ before being sieved on 12-inch (300 mm) sieves.

2. Balances used in weighing mineral filler samples must be sensitive to __________.

3. Which sieves are used in testing mineral filler samples? ____

4. The minimum weight of a mineral filler test sample should be __________.

5. When sieving mineral filler, weights should be recorded to the nearest __________ and percentages to the nearest __________.

6. When you wash a mineral filler sample, should you pour both water and sample onto the nested sieves? __________

7. The results of gradation tests on hot bin samples are used to determine the __________________ of aggregates needed from each bin to achieve a combined aggregate mixture that compares favorably with the __________________________________.

8. When will you know for sure whether or not the combination of aggregates in the hot mix compare favorably with the job mix formula? ____

Check your answers on page 5-39, if you got the right answers, continue - if not go back over the material.

WASHING, SIEVING, AND WEIGHING EXTRACTED AGGREGATES

The results of gradation tests performed on aggregates extracted from hot mix samples tell you if the combined aggregates compare favorably with the job mix formula. We will discuss the gradation test procedures and requirements here briefly, but the extraction test itself is discussed in the next chapter.

The procedures for testing extracted aggregates are similar to those for testing fine aggregates.

You must wash extracted aggregates carefully and thoroughly -- according to the same basic procedures we discussed earlier for fine aggregate. Typically, you will need to wash the sample 8 to 12 times before the water becomes clear. Then, return the aggregates retained on the No. 8 (2.36 mm) and No. 200 (75 μm) sieves to those in the pan and dry the washed sample to a constant weight. Determine and record the weight of minus 200 (-75 μm) material lost.

Now you sieve the plus 200 (+75 μm) aggregates on the sieves specified on the Design Mix. Calculate weights and percentages passing and record these on the Extraction Worksheet.

QUIZ

1. Which of the following give inaccurate gradation test results?

   ___ A. Dusty scale weighing pan
   ___ B. Scale out of balance
   ___ C. Dirty sieves
   ___ D. Spilling the sample
   ___ E. Losing dust from the sample
   ___ F. Losing one pebble from the sample

2. Aggregate gradation requirements tell you the percentages of aggregates that must ______________________________________.

3. Standard sieve sizes are designated in ________________, while alternate designations are in ____________ and ______________________________.

4. Is minus 3/8 (-9.5 mm) material coarser than the openings of a 3/8-inch (9.5 mm) sieve? __________

5. All minus No. 8 (-2.36 mm) material can be considered __________ aggregate.

6. How many openings are in 1 linear inch of a No. 4 sieve? ________

7. What two types of sieves are used in gradation tests? ________________ and ______________

8. The nominal maximum particle size of the aggregates to be tested is 1 inch (25.0 mm). What minimum sample weight should you use for testing? __________ pounds

9. Aggregates should be dried to a constant weight in ovens capable of maintaining a uniform temperature of ____________________.

10. Fine aggregate samples, bin samples, and extracted aggregates should be weighed to the nearest ________ on the _______________.

11. Mineral filler samples should be weighed to the nearest ________________.

12. Use the information below to complete the gradation worksheet for the aggregate sample being tested.
    1. The test sample weighs 2245.1 g.
    2. No aggregates are retained on the 3/4-inch (19.0 mm) sieve.
    3. On the 1/2-inch (12.5 mm) sieve, 109.0 g of material is retained.
    4. Thereafter, cumulative weights of 467.1, 1252.2, 1887.4, 1932.3, 2009.2, 2115.1, 2210.4, 2235.6 and 2245.1 g are obtained.

ORIGINAL DRY WEIGHT: ____________________
TYPE MATERIAL: ____________________
SAMPLE NUMBER: ____________________

SIEVE	CUMULATIVE WEIGHT [g]	TOTAL % RETAINED	TOTAL % PASSING
19.0 mm (3/4)			
12/5 mm (1/2)			
9.5 mm (3/8)			
4.75 mm (4)			
2.35 mm (8)			
1.18 mm (16)			
600 μm (No. 30)			
300 μm (No. 50)			
150 μm (No. 100)			
75 μm (No. 200)			
-75 μm pan (-200)			

13. Why are fine aggregate samples washed before being sieved? ____
____

14. Washed samples are decanted over a __________ (No.___) sieve and a __________ (No.___) sieve.

15. How long do you wash a sample? ____

16. The minimum weight of a mineral filler test sample should be ____________. Should mineral filler samples be washed before being tested? __________

17. The results of gradation tests on hot bin samples are used to determine the _________________ of aggregate needed from each bin to achieve a combined aggregate mixture that complies with the limits of the_____________.

18. What tells you if the combined aggregates comply with the limits referred to above? ________________
____

Check your answers beginning on the next page, if you got all the correct answers, "Congratulations" go on to Chapter 6. If not go back over the material in Chapter 5.

This is the end of Chapter Five. If you still feel that you need to review any parts of the chapter, do so before continuing in the course.

ANSWERS TO QUESTIONS

Page 5-4

1. Standard Specifications, Mix Design
2. pass each specified sieve size
3. weight

Page 5-9

1. millimeters
2. Yes
3. 1/2 (12.5), 3/4 (19.0)
4. coarse
5. 3/8 (9.5)
6. 16
7. 1/4 (6.3)
8. 64
9. 50

Page 5-11

1. 8-inch (200 mm), 12-inch (300 mm)
2. Specifications covering the material to be tested.

Page 5-15

1. 11, 5
2. 1.0 lb (500 grams)
3. B, C
4. two
5. Gram scale
6. No
7. 0.1%

Page 5-31

1. B
2. 3
2
5
1
4
6
7

Page 5-34

1. washed
2. 0.1 g
3. No. 30, No. 80, No. 200 (600 μm, 180 μm, 75 μm)
4. 100 g
5. 0.1 g, 0.5%
6. Yes
7. proportions, job mix formula
8. When gradation tests are performed on the aggregates extracted from hot mix samples.

Page 5-36

1. All of them
2. pass each specified sieve size
3. millimeters, inches, openings per inch
4. No
5. fine
6. Four

7. 8-inch (200 mm)
   12-inch (300 mm)
8. 10
9. 230 ± 9°F
10. 0.1 g, gram scale
11. 0.1 gram
12. Here are the answers to the gradation test:

ORIGINAL DRY WEIGHT: 2245.1 g
TYPE MATERIALS: ______
SAMPLE NUMBER: ______

SIEVE	CUMULATIVE WEIGHT [gm]	TOTAL % RETAINED	TOTAL % PASSING
19.0 mm (3/4)	0.00	0	100
12.5 mm (½)	109.0	5	95
9.5 mm (3/8)	467.1	21	79
4.75 mm (4)	1252.2	56	44
2.36 mm (8)	1887.4	84	16
1.18 mm (16)	1932.3	86	14
600 μm (No. 30)	2009.2	89	11
300 μm (No. 50)	2115.1	94	6
150 μm (No. 200)	2210.4	98	2
75 μm (200)	2235.6	99.6	0.4
-75 μm pan (-200)	2245.1	100	

13. To help determine the total amount of minus 200 (-75 μm) material
14. 2.36 mm (#8), 75 μm (#200)
15. Until the wash water runs clear
16. 100 grams, Yes
17. proportions, job mix formula
18. Results of gradation tests on aggregates extracted from hot mix samples

CHAPTER SIX

Extraction Testing

CONTENTS

PERFORMING EXTRACTION TESTS

So far, we have discussed the sampling and testing of the materials used in hot mix -- aggregates, asphalt cements, and hot mix asphalt in Chapters 2, 4 and 5. Now, we will discuss one of the test procedures that is used for testing of the hot mix asphalt.

One test that the plant technician must conduct is the extraction test. The purpose of the test is to extract the asphalt from the sample in order to determine the asphalt content. In addition, the aggregate remaining from this method can be used for gradation analysis. The results are compared to the mix design to see if the mix has the proper percentage of asphalt and aggregate gradation. The method used to conduct this test is extraction by ignition oven.

This chapter will discuss this method. It is covered in more detail in the FDOT Construction Training Qualification Program (CTQP) course, Asphalt Plant Level I.

Quantitative Determination of Asphalt Content from Asphalt Paving Mixtures by the Ignition Method (FM 5-563)

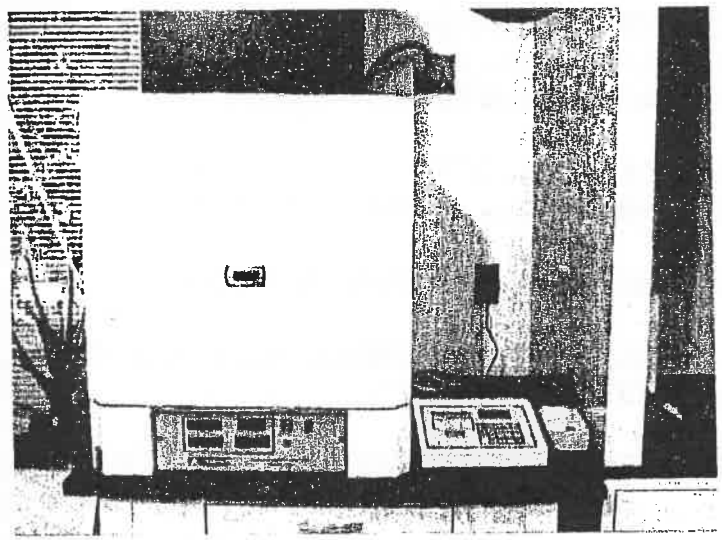
This test method is used to determine the asphalt content of an asphalt mixture by placing the sample in a furnace where the mix is heated to 1000°F (538°C) and the asphalt cement is burned off. The asphalt cement content is calculated from the initial weight of the sample, the final weight of the remaining aggregate, a temperature compensation factor for the measurement system and a calibration factor for the mix. The asphalt content is expressed as both a weight loss in grams and as a weight percentage of the initial sample weight.

This self-study course will provide a general overview of the test procedure. The Asphalt Plant Level I course will cover the mixture calibration procedure. Prior to using the laboratory equipment, the technician must be thoroughly familiar with its operation. **The safety instructions must be followed diligently at all times.**

THE FURNACE

The furnace used for the ignition test is a forced-air furnace capable of maintaining a temperature up to 1200°F. The furnace contains an internally mounted load cell, accurate up to 0.1 g. The furnace has an automated system for data collection and processing. The system will provide a printout of the results to include the initial specimen weight, specimen weight loss, temperature compensation factor, mix calibration factor, calibrated asphalt content (%), test duration time, and furnace set-point temperature. The furnace contains an exhaust system with a filter, afterburner or some combination that reduces the furnace emissions to an acceptable level.

The furnace is equipped with a door that will lock automatically when the test is started and will remain locked until completion of the test.



SAFETY IS ESSENTIAL WITH THIS TEST.

The test is run at very high temperatures and it is very easy to sustain a major burn.

Safety items are a must.

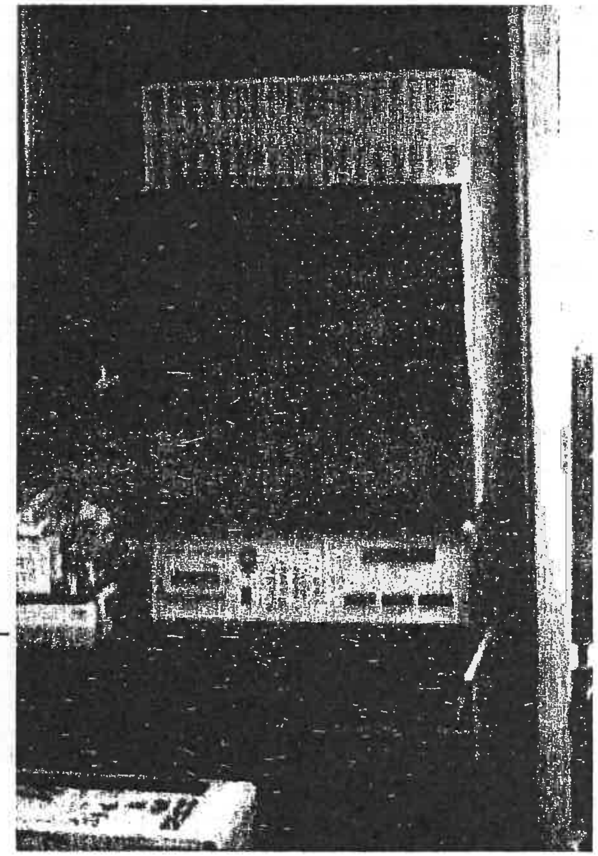
Long sleeve gloves capable of withstanding high temperatures are needed. These gloves need to be in good shape (no holes). A face shield is needed for the protection of the technician while loading and unloading the oven.

A long sleeve jacket is needed during the testing. While you wouldn't want anything to actually touch the jacket, it will offer some measure of protection.

A heat resistant surface is needed so that the baskets can be left to cool.

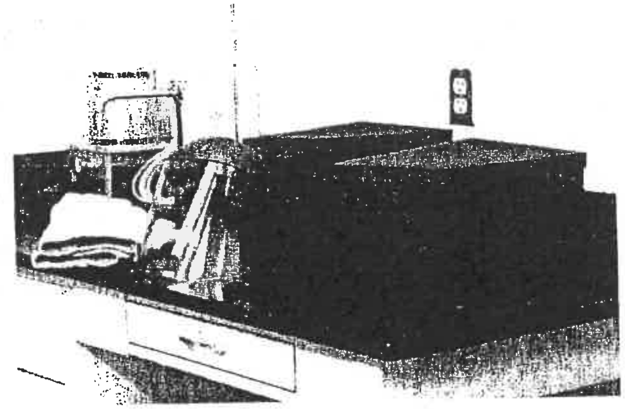
A protective cage is used to cover the hot baskets and is appropriately marked. The oven must be equipped with a good ventilation system.

Each of these items will be discussed in further detail as the test procedure is discussed.



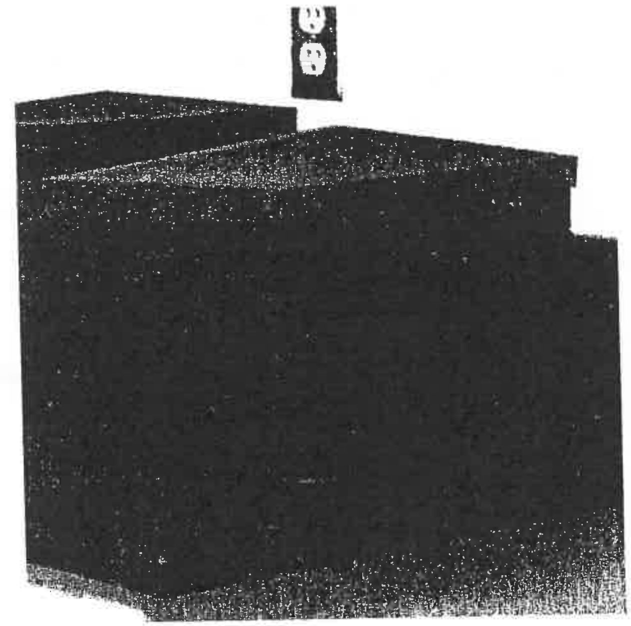
SAFETY EQUIPMENT

It is essential that proper safety equipment be used during the test. This photo shows the gloves and the face shield that are needed. **IT IS ABSOLUTELY ESSENTIAL THAT THESE BE USED WHEN RUNNING THE TEST.**



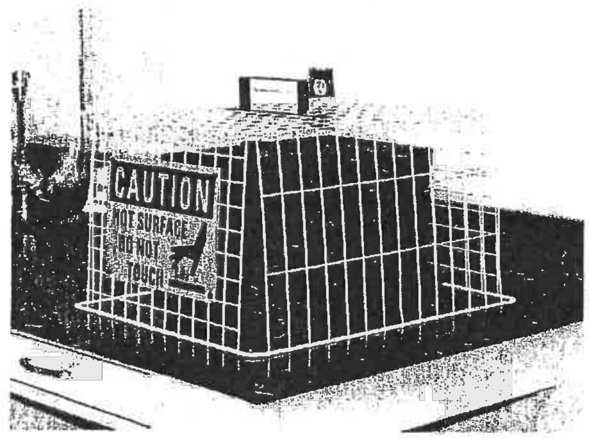
THE BASKETS

A minimum of two tempered stainless-steel baskets, of perforated metal or mesh, is used to hold the HMA samples used in the test. The baskets nest together and provide shielding on the corners to minimize the loss of aggregate particles. The nested baskets sit in a catch pan approximately 1 inch (25 mm) deep.



THE PROTECTIVE CAGE

The sample baskets must be placed on a heat resistant surface capable of withstanding temperatures of up to 1200°F. Also, a protective cage must be used to surround and isolate the sample baskets.



THE BALANCE

A balance with a capacity of 8 kg or greater and accurate to 0.1 g is needed.

QUIZ

1. The following safety equipment is needed for the test procedure:

   ____
   ____
   ____
   ____

2. The heat resistant surface must be capable of withstanding what temperature? ______________________

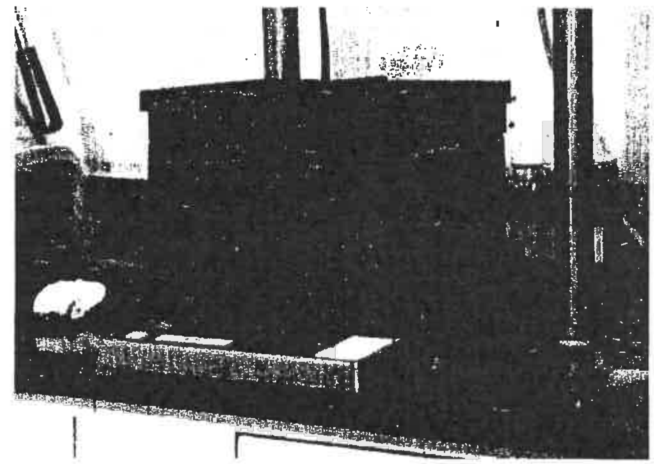
Check your answers on page 6-15, if you got the right answers, continue - if not go back over the material.

THE TEST PROCEDURE

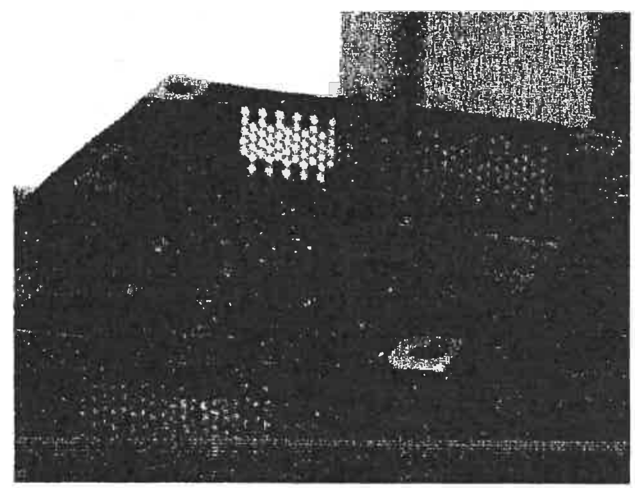
Step 1 - The furnace is to be preheated to 1000°F.

Step 2 - A correction factor of 0.00 is entered into the control panel of the furnace.

Step 3 - Weigh and record the weight of the sample baskets and the catch pan with the sample guards in place.



Step 4 - Prepare the sample by carefully breaking it up into 1/4 inch or smaller pieces. Spread approximately ½ of the sample in the low basket, keeping the material approximately one inch away from the edges of the basket. Place the upper sample basket on the bottom basket assembly. Evenly distribute the remaining material in the top basket.



Step 5 - Weigh the sample and the entire basket assembly (making sure to include the entire assembly). Subtract the weight of the sample baskets (Step 3) from this weight to obtain the mixture weight (Line C - below).

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Asphalt Plant - Ignition Oven Worksheet

Fin. Proj ID: 219450-1-52-01	Lot Begin Date 6/1/2002	Mix Design No.: 02-4567
Mix Type: 12.5	Traffic Level D	Technician: A 123 456 78

LOT #		Sublot 1	Sublot 2	Sublot 3	Sublot 4
	Tons	1			
ASPHALT CONTENT DETERMINATION:	Date	06/01/02			
A Basket Assembly weight, g		3279.4			
B Basket Assembly + Sample weight before Test, g		5404.9			
C Initial Sample Weight, g, (B-A)		2125.5			
D Basket Assembly + Sample weight after Test, g					
E Final Sample Weight, g, (D-A)					

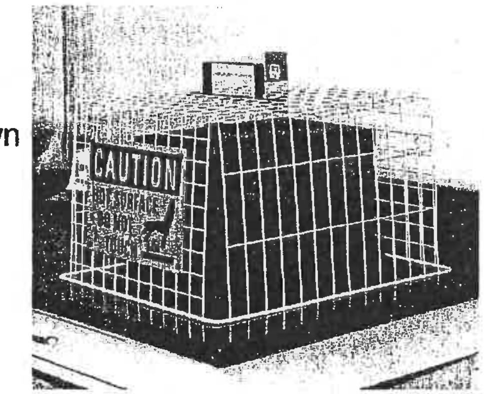
Step 6 - Input the initial mixture weight rounded to the nearest gram into the ignition furnace controller. CHECK TO MAKE SURE THAT YOU ENTERED THE CORRECT WEIGHT.

Step 7 - With the protective equipment on, open the chamber of the oven and place the sample basket assembly in the furnace. Ensure that the basket assembly is not touching the furnace sides. Close the chamber door and initiate the test by pushing the start/stop button.

Step 8 - Allow the test to continue until the stable light or audible alarm indicates that the test is complete. Press the start/stop button.

Step 9 - Using the safety equipment, open the door, and remove the baskets. **SPECIAL NOTE - The safety equipment must be used for this step, as the sample is extremely hot!!**

Step 10 - Place the basket assembly on the heat-resistant counter top and cover with the protective cage. The sample should be allowed to cool to room temperature. This will take about 30 minutes. The final weight of the sample is then determined (Line E - below). Use a timer to insure that the sample has been sitting long enough to cool down so that it can be handled.



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MATERIALS 07/02

Asphalt Plant - Ignition Oven Worksheet

Fin. Proj ID: 219450-1-52-01	Lot Begin Date 6/1/2002	Mix Design No.: 02-4567			
Mix Type: 12.5	Traffic Level D	Technician: A 123 456 78			
LOT #		Sublot 1	Sublot 2	Sublot 3	Sublot 4
	Tons	1			
ASPHALT CONTENT DETERMINATION:	Date	06/01/02			
A Basket Assembly weight, g		3279.4			
B Basket Assembly + Sample weight before Test, g		5404.9			
C Initial Sample Weight, g, (B-A)		2125.5			
D Basket Assembly + Sample weight after Test, g		5271.3			
E Final Sample Weight, g, (D-A)		1991.9			

Step 11 - The calibrated asphalt content is obtained from the furnace printout. It is then corrected using the mix calibration factor. The procedures for determining the mix calibration factor are included in the Asphalt Plant Level I course.

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MATERIALS 07/02

Asphalt Plant - Ignition Oven Worksheet

Fin. Proj ID: 219450-1-52-01	Lot Begin Date 6/1/2002		Mix Design No.: 02-4567			
Mix Type: 12.5	Traffic Level D		Technician: A 123 456 78			
LOT #			Sublot 1	Sublot 2	Sublot 3	Sublot 4
		Tons	1			
ASPHALT CONTENT DETERMINATION:		Date	06/01/02			
A Basket Assembly weight, g			3279.4			
B Basket Assembly + Sample weight before Test, g			5404.9			
C Initial Sample Weight, g, (B-A)			2125.5			
D Basket Assembly + Sample weight after Test, g			5271.3			
E Final Sample Weight, g, (D-A)			1991.9			
PRINT OUT AC CONTENT CALCULATIONS:						
F Measured AC from Furnace Print Out, %			6.19			
G Calibration Factor (see approved Mix Design), %			0.15			
H Calibrated AC Content, %, (F+G)	Design AC, %	6.5	6.34			

QUIZ

1. The ignition oven is preheated to __________.

2. The sample to be placed in the basket is prepared by breaking it up into ________ or smaller particles.

3. If the sample and sample basket assembly weighs 3800 grams and the basket assembly weighs 1800 grams what is the weight of the HMA sample? ____________________

The answers begin on page 6-15. If all are correct, continue - if not go back over the material.

Aggregate Gradation

Now, you must perform the gradation test on the extracted aggregates -- following the procedures similar to those discussed in Chapter Five.

First, record the total aggregate weight -- 1991.3 -- on line I of the Worksheet, as shown.

Run the gradation test and calculate and record the results on the appropriate lines. Note a small amount of minus 75 μm (200) material remained in the aggregates -- 19.8 g. Record this weight on line W.

The percent of material passing the 75 μm (No. 200) sieve -- 10.18% is based on 202.7 g, not 19.8 g. This includes both the material passing through the 75 μm (No. 200) sieve and the material lost due to washing (line K).

I	Weight of Extracted Aggregate (after basket is cleaned). g		1991.3	
	Note: The difference between E & I shall not be more than 0.2% of E.			
J	Weight of Washed Sample, g		1808.4	
K	Weight of - 75um Mat'l lost due to Washing. g. (I-J)		182.9	
L	Accumulated Wt. Of Material Retained 1" (25.0mm). g		0.0	
M	Accumulated Wt. Of Material Retained 3/4" (19.0mm). g		0.0	
N	Accumulated Wt. Of Material Retained 1/2" (12.5mm). g		0.0	
O	Accumulated Wt. Of Material Retained 3/8" (9.5mm). g		145.9	
P	Accumulated Wt. Of Material Retained No.4 (4.75mm). g		545.8	
Q	Accumulated Wt. Of Material Retained No.8 (2.36mm). g		961.9	
R	Accumulated Wt. Of Material Retained No.16 (1.18mm). g		1290.4	
S	Accumulated Wt. Of Material Retained No.30 (600:m). g		1482.8	
T	Accumulated Wt. Of Material Retained No.50 (300 µm). g		1651.0	
U	Accumulated Wt. Of Material Retained No.100 (150 µm). g		1760.3	
V	Accumulated Wt. Of Material Retained No.200 (75 µm), g		1789.0	
W	Weight of Material Passing No. 200(75um). (Pan), g	Target	19.8	
X	% Material Passing 1" (25.0mm). 100-(L/I x 100)			
Y	% Material Passing 3/4" (19.0mm). 100-(M/I x 100)			
Z	% Material Passing 1/2" (12.5mm). 100-(N/I x 100)	100		
AA	% Material Passing 3/8" (9.5mm). 100-(O/I x 100)	92	92.67	
BB	% Material Passing No.4 (4.75mm). 100-(P/I x 100)	73	72.59	
CC	% Material Passing No.8 (2.36mm). 100-(Q/I x 100)	53	51.69	
DD	% Material Passing No.16 (1.18mm). 100-(R/I x 100)	36	35.20	
EE	% Material Passing No.30 (600µm). 100-(S/I x 100)	26	25.54	
FF	% Material Passing No.50 (300µm). 100-(T/I x 100)	18	17.09	
GG	% Material Passing No.100 (150µm). 100-(U/I x 100)	12	11.60	
HH	% Material Passing No.200 (75µm). (K+W)/I x 100)	8.9	10.18	

The completed Extraction Worksheet is shown here. We have determined both the percentage of bitumen in the mix and the gradation of the aggregates in the mix. These are compared with the Design Mix to see if the asphaltic concrete meets the requirements.

You must record the bitumen percentage and the gradation data on the appropriate asphalt plant daily forms.

As a final step, be sure to properly clean and store all test equipment.

State Of Florida Department Of Transportation

MATERIALS

Asphalt Plant - Ignition Oven Worksheet

Fin. Proj ID: 219450-1-52-01 Lot Begin Date 6/1/2002 Mix Design No.: 02-4567

Mix Type: 12.5 Traffic Level D Technician: A 123 456 78

LOT #		Sublot 1	Sublot 2	Sublot 3	Sublot 4
	Tons	1			
ASPHALT CONTENT DETERMINATION:	Date	06/01/02			
A Basket Assembly weight, g		3279.4			
B Basket Assembly + Sample weight before Test, g		5404.9			
C Initial Sample Weight, g, (B-A)		2125.5			
D Basket Assembly + Sample weight after Test, g		5271.3			
E Final Sample Weight, g, (D-A)		1991.9			
PRINT OUT AC CONTENT CALCULATIONS:					
F Measured AC from Furnace Print Out, %		6.19			
G Calibration Factor (see approved Mix Design), %		0.15			
H Calibrated AC Content, %, (F+G) Design AC, %	6.5	6.34			
WASHED SIEVE ANALYSIS					
I Weight of Extracted Aggregate (after basket is cleaned), g		1991.3			
Note: The difference between E & I shall not be more than 0.2% of E.					
J Weight of Washed Sample, g		1808.4			
K Weight of - 75um Mat'l lost due to Washing, g, (I-J)		182.9			
L Accumulated Wt. Of Material Retained 1" (25.0mm), g		0.0			
M Accumulated Wt. Of Material Retained 3/4" (19.0mm), g		0.0			
N Accumulated Wt. Of Material Retained 1/2" (12.5mm), g		0.0			
O Accumulated Wt. Of Material Retained 3/8" (9.5mm), g		145.9			
P Accumulated Wt. Of Material Retained No.4 (4.75mm), g		545.8			
Q Accumulated Wt. Of Material Retained No.8 (2.36mm), g		961.9			
R Accumulated Wt. Of Material Retained No.16 (1.18mm), g		1290.4			
S Accumulated Wt. Of Material Retained No.30 (600µm), g		1482.8			
T Accumulated Wt. Of Material Retained No.50 (300µm), g		1651.0			
U Accumulated Wt. Of Material Retained No.100 (150µm), g		1760.3			
V Accumulated Wt. Of Material Retained No.200 (75µm), g		1789.0			
W Weight of Material Passing No. 200(75um), (Pan), g	Target	19.8			
X % Material Passing 1" (25.0mm), 100-(L/I x 100)					
Y % Material Passing 3/4" (19.0mm), 100-(M/I x 100)					
Z % Material Passing 1/2" (12.5mm), 100-(N/I x 100)	100				
AA % Material Passing 3/8" (9.5mm), 100-(O/I x 100)	92	92.67			
BB % Material Passing No.4 (4.75mm), 100-(P/I x 100)	73	72.59			
CC % Material Passing No.8 (2.36mm), 100-(Q/I x 100)	53	51.69			
DD % Material Passing No.16 (1.18mm), 100-(R/I x 100)	36	35.20			
EE % Material Passing No.30 (600µm), 100-(S/I x 100)	26	25.54			
FF % Material Passing No.50 (300µm), 100-(T/I x 100)	18	17.09			
GG % Material Passing No.100 (150µm), 100-(U/I x 100)	12	11.60			
HH % Material Passing No.200 (75µm), (K+W)/I x 100)	8.9	10.18			

Remarks

QUIZ

Answer the questions below, based on the following data:

The weight of the extracted aggregate sample is 775.1 g. The dried weight of the aggregate after washing is 706.4 g. In the gradation test, 7.7 g of material passes the No. 200 (75 μm) sieve.

1. What was the total weight of minus No. 200 (75 μm) material? __________
2. What is the percent of material passing the No. 200 (75 μm) sieve? __________
3. On what report form do you record the bitumen percentage and gradation data?

   ____

Check your answers beginning on the next page, if you got all the correct answers, "Congratulations" go on to Chapter 7. If not go back over the material in Chapter 6.

This is the end of Chapter Six. If you still feel that you need to review any parts of the chapter, do so before continuing in the course.

ANSWERS TO QUESTIONS

Page 6-7

1. Gloves
   Face Shield
   Heat Resistant surface
   Safety cage
   Long sleeve jacket
2. 1200° F

Page 6-11

1. 1000° F
2. 1/4 inch
3. 2000 g

Page 6-14

1. 76.4 g
2. 9.86 %
3. the appropriate asphalt plant daily forms

CHAPTER SEVEN

Bulk Specific Gravity Tests (FM 1-T 166)

CONTENTS

BULK SPECIFIC GRAVITY TESTS (FM 1-T 166)

In this chapter we will discuss the bulk specific gravity test, FM 1-T 166.

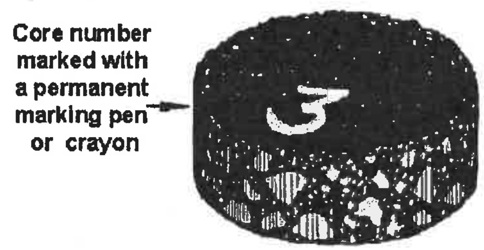
The test is performed on roadway core samples or laboratory compacted samples to determine the density of hot mix asphalt. For Superpave projects, the bulk specific gravity test will be used to determine the density of roadway cores.

OBTAINING AND HANDLING CORE SAMPLES

Before performing the tests, you have to have samples of the compacted material. These samples are obtained either from a project site or from laboratory compacted samples. The Asphalt Concrete Paving Level I training course explains how these cores are obtained.

Before running the density tests, inspect the cores -- particularly the edges -- to see that they have not been damaged while cutting or transporting them. Do not test a damaged core, because the density would change.

CORE SAMPLE OF FINISHED PAVEMENT



QUIZ

1. Core samples are tested to determine the ______________________________ of specimens of compacted asphalt concrete pavements.

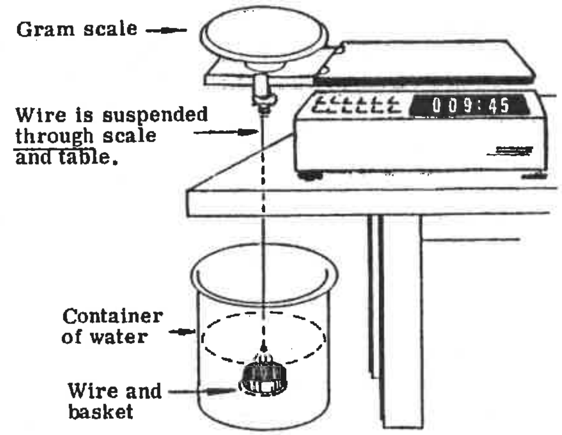
2. What would happen to a core if you dropped and bent it? ____

Check your answers on page 7-8. If you got the correct answers - continue. If not go back and review the material.

TESTING CORE OR LABORATORY COMPACTED SAMPLES

EQUIPMENT

You have the core sample on hand -- so now let's look at the equipment needed to perform the density test:



- brush
- digital scale -- with a capacity of 5 kg or more and sensitive to 0.1 g or less -- equipped with a wire and basket suspended from the center of the scale pan.
- thermometer
- container of water at 77 ± 2°F with overflow outlet

PROCEDURE

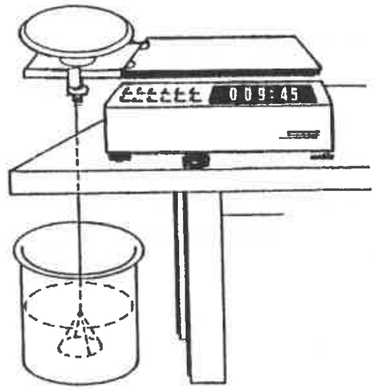
With the equipment clean and ready --let's go through the test procedures as illustrated in the following steps:

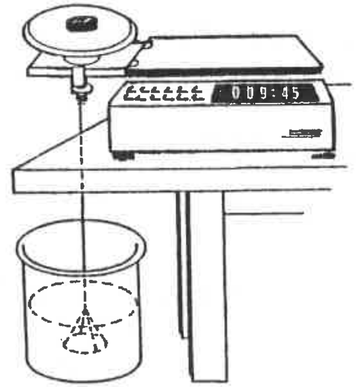
1. Clean the core with water or a brush -- using care in handling to prevent changing the density.

2. Air dry the core to a constant weight in a cool place. Do not use an oven. Placing the core in front of a fan to cool it is the preferred method.

3. Balance the scale, with the wire and basket suspended in water. Note the weight of the wire and basket. It must be subtracted from the scale readings to find the actual weights of the core in the steps that follow. Some scales have the capability to "tare" or re-zero before weighing the sample.

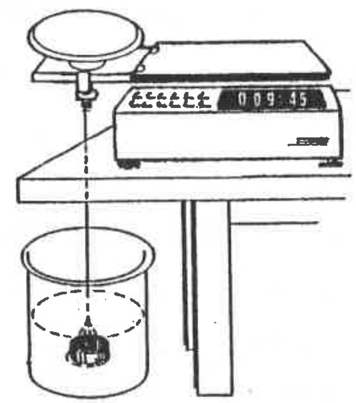
4. Weigh the core in air and note the weight to the nearest 0.1 g -- for example, 682.3 g. Record the weight on your worksheet, after subtracting the weight of the wire and basket (if necessary).





The water level should be held constant from one test to the next. Note that the weight is recorded as the "DRY WT" for the core.

5. Now immerse the core in water for three to five minutes and weigh it immersed. Record the weight on the worksheet as the "WT. IN WATER." (Remember to subtract the weight of the wire and basket from the scale reading, if necessary.)



6. Remove the core from the water and surface dry it by blotting with a damp towel. Weigh the core in air and record the weight (scale reading less wire and basket, if necessary) on the worksheet as the "SSD WT." (Saturated Surface-Dry Weight).

7. The last step is to calculate the bulk specific gravity and the core density (specific gravity times the unit density of water). In our example, the calculation is shown below.

Bulk Specific Gravity (G_{mb}) = [A/(B-C)]

A = weight of specimen in Air or DRY WT. (g)
B = weight of saturated surface dry specimen (SSD) (g)
C = underwater weight of specimen (g)

Core Density (lb/ft^3) = Bulk Specific gravity x 62.4 lbs/ft^3

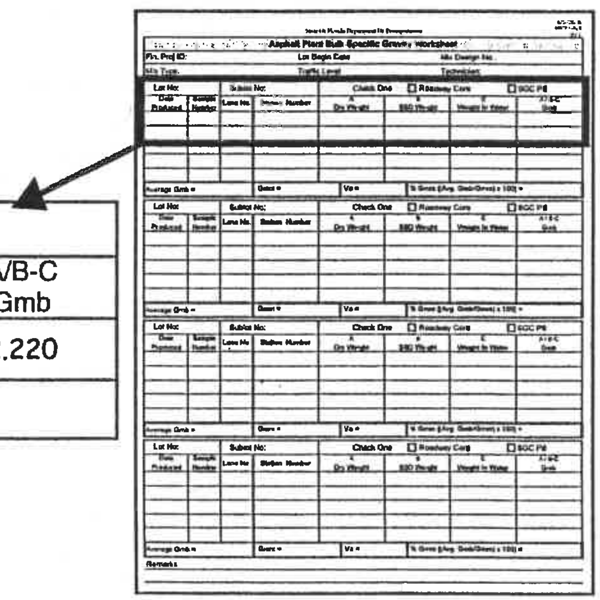
Example:

A = weight of specimen in Air or DRY WT. = 682.3 g
B = weight of saturated surface dry specimen (SSD) = 756.2 g
C = underwater weight of specimen = 448.6 g

Bulk Specific Gravity (G_{mb}) = [A/(B-C)] = [682.3/(756.2 - 448.8)] = 2.220

or

using an excerpt from the Asphalt Plant Bulk Specific Gravity Worksheet)



Lot No:		Sublot No:		Check One ☐ Roadway Core ☐ SGC Pill			
Date Produced	Sample Number	Lane No.	Station Number	A Dry Weight	B SSD Weight	C Weight in Water	A/B-C Gmb
	1			682.3	756.2	448.8	2.220

Core density = 2.220 x 62.4 = 138.5 lb/ft^3

Let's review up to this point, by taking the quiz on the following page.

QUIZ

1. The scale should have a capacity of _____ kg or more. The scale should be sensitive to ________ or less.

2. A wire and basket are suspended from the center of the scale pan and into a ______________________________.

3. Before weighing anything, you should tare the scale:

   __ A. with the wire and basket suspended in air.
   __ B. without the wire and basket.
   __ C. with the wire and basket suspended in water.

4. The first weighing during the test is to find the ______________________ of the core.

5. Put the remaining test steps in order by numbering them.

   __ surface dry core
   __ determine the SSD weight by weighing it air
   __ weigh in water
   __ immerse core in water

6. A core has been tested and the following was determined:

   Dry weight = 651.2 g
   Weight in water = 445.3 g
   Surface dry weight = 734.6 g

   What is the bulk specific gravity of the core? ______________________________
   What is the bulk density of the core? ______________________________

Check your answers on page 7-8. If you have any problems - review the material again.

ANSWERS TO QUESTIONS

<u>Page 7-3</u>

1. bulk specific gravity
2. the density would change

<u>Page 7-7</u>

1. 5, 0.1
2. container of water
3. C
4. dry weight
5. 3, 4, 2, 1
6. a. Bulk specific gravity = 2.251
   b. Core density = 140.5 lbs/ft^3

CHAPTER EIGHT

Maximum Specific Gravity (FM 1-T 209)

CONTENTS

MAXIMUM SPECIFIC GRAVITY (FM 1-T 209)

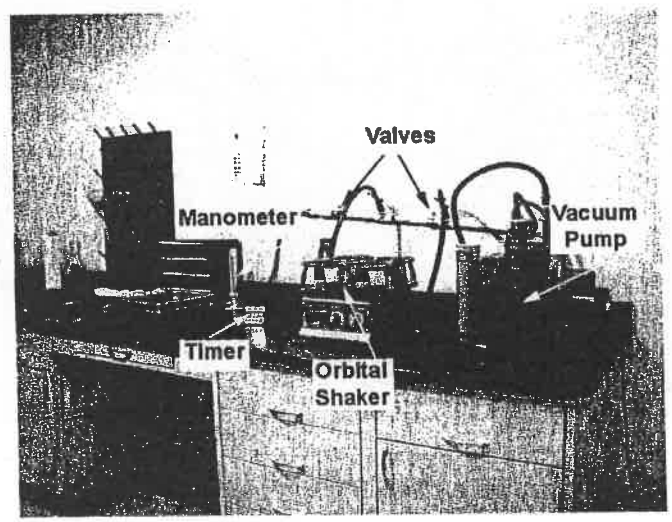
GENERAL DESCRIPTION OF THE TEST PROCEDURE

The maximum specific gravity is the ratio of the mass of a given volume of cooled uncompacted hot mix asphalt (HMA) at 77°F (25°C) to the mass of an equal volume of water at the same temperature. The procedure is often called the Rice test after its developer, James Rice. The maximum specific gravity is used in conjunction with the bulk specific gravity to determine the in-place density and/or the percent air voids (V_a) in a compacted HMA sample. The percentage air voids (V_a) is significant because the durability, permeability and rutting characteristics of the HMA are influenced by the amount of voids in the compacted material. This test is covered in more detail in the Asphalt Plant Level I course being taught under the FDOT's Construction Training and Qualification Program. It is also suggested that you obtain and read a copy of the test procedure (FM 1-T 209) as you go through this chapter.

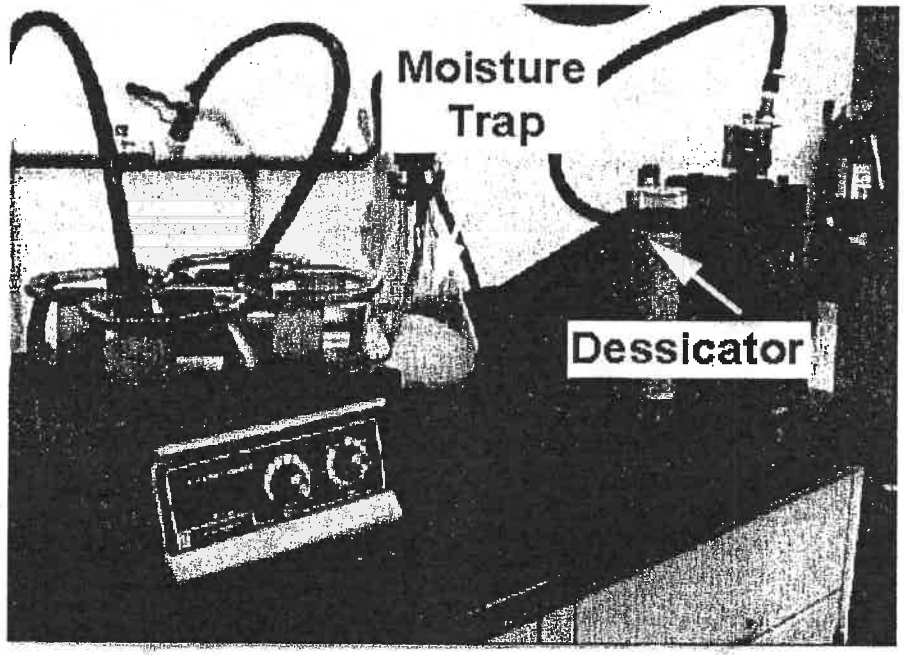
REQUIRED EQUIPMENT

To conduct the test, a number of pieces of equipment are needed for this test method (see the figure below):

1. A scale or balance with a 10 kg capacity, readable to 0.1 g
2. A vacuum pump capable of producing a partial vacuum of 30 mm Hg or less absolute pressure. This pump is usually a dual stage pump in order to achieve the required vacuum pressure.
3. A small mercury manometer readable to 0.1 mm is used for easy reading of the residual pressure
4. A orbital shaker with places for holding a minimum of two flasks (3/4 inch orbit and 270 ± 9 rpm)
5. A stop watch or timer that is used to measure the duration of the vacuum and the shaking
6. Valves for controlling the pressure to each flask

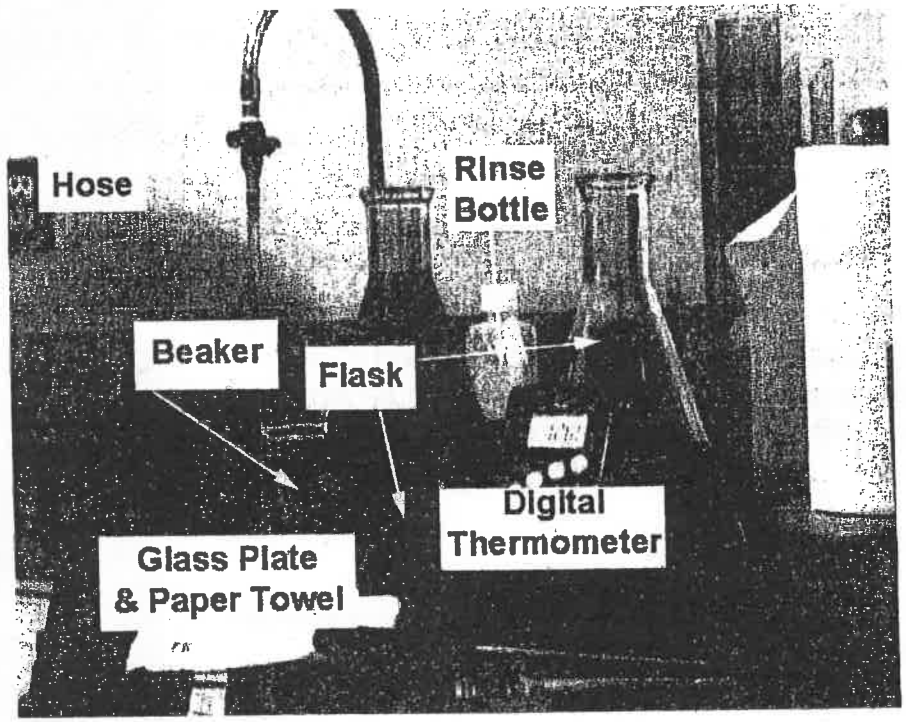


In addition to the above equipment, a dessicator and a moisture trap are needed to prevent moisture from being pulled into the vacuum which would seriously damage the vacuum pump. The dessicator granules are purple in color when they are dry. When they have absorbed as much water as they can they will become a pinkish color. They can be dried in a warm oven and reused. The figure below shows the moisture trap and the dessicator.



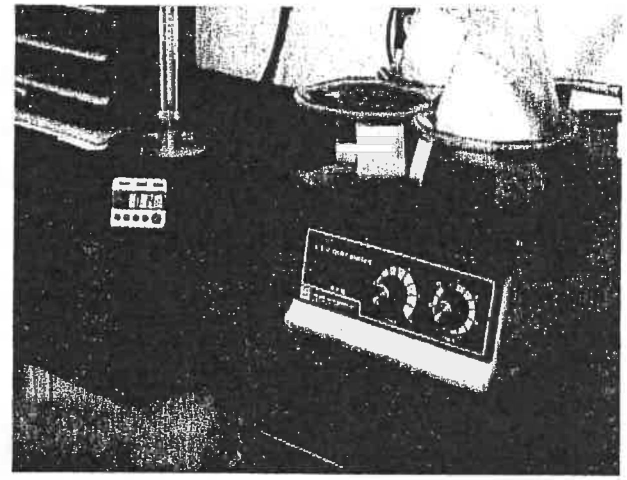
In addition, the following pieces of support equipment are needed:

1. Two 2,000 milliliter flasks. Do not use a vacuum flask in place of the one shown. The vacuum arm of these types of flasks does not allow accurate volumetric determination.
2. A plastic squirt bottle to be used for a rinse bottle.
3. A glass plate and paper towels
4. A digital thermometer (commonly used instead of a glass and mercury thermometer)
5. A paint brush for brushing the finer particles of the dry mix out of the pan and into the flasks.
6. A hose attached to a water faucet to be used to fill the flasks.



8. Apply a vacuum of 30 ± 2 mm mercury. The vacuum should be achieved in less than 2 minutes.

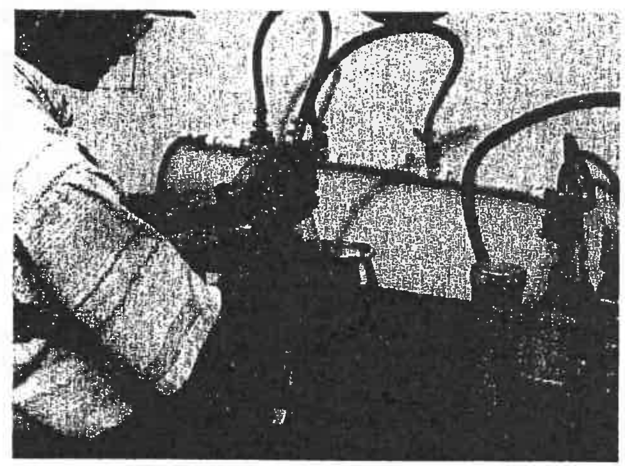
9. Turn on the shaker table and adjust to the required RPMs. Make sure that the water level in the flasks is low enough not to be vacuumed into the hose and water traps and it is also high enough so that the mix is not exposed when agitated.



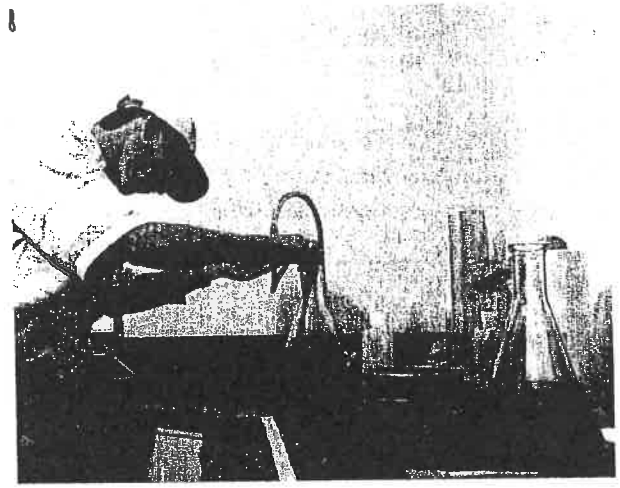
10. At the end of the test, turn the pump off, then slowly bleed off the pressure. If the pressure is reduced too quickly, air can become entrapped in the water and sample. Once the pressure is released, remove the stoppers.

Start the stop watch here.

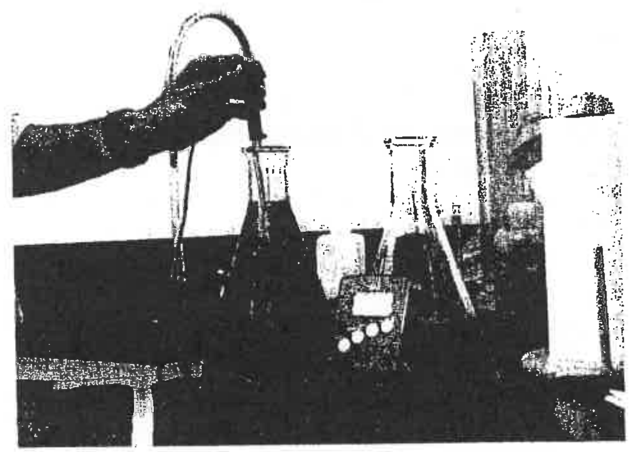
Make sure to always keep the sample completely immersed in water while removing the flask from the shaking table.



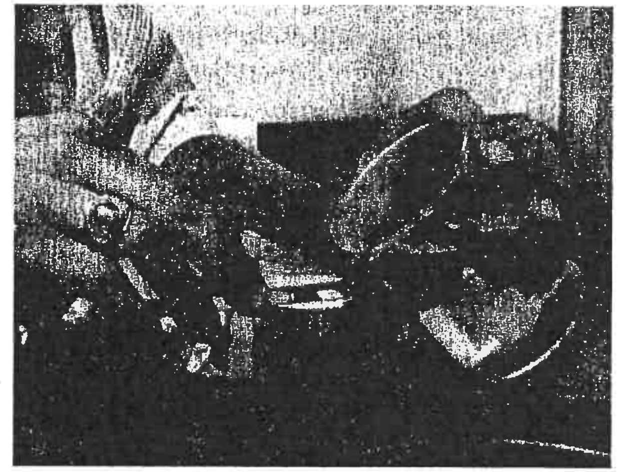
11. Slowly fill the flasks with water to just below the top. The hose from the sink is submerged below the water surface. This is done to keep air from being entrapped in the water.



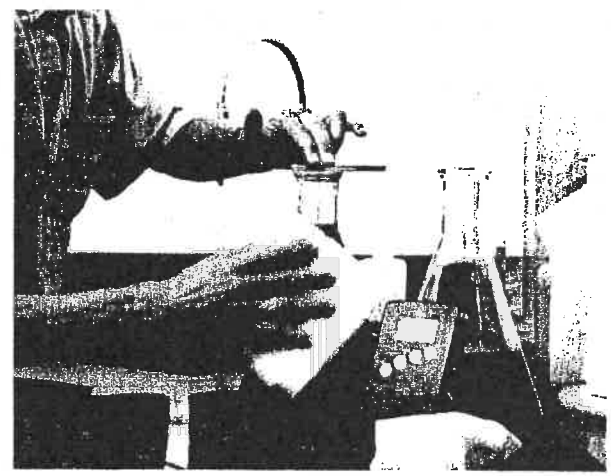
12. Immediately determine the temperature of the water in each flask. This temperature will be used to correct the final test results for temperatures other than 77°F.



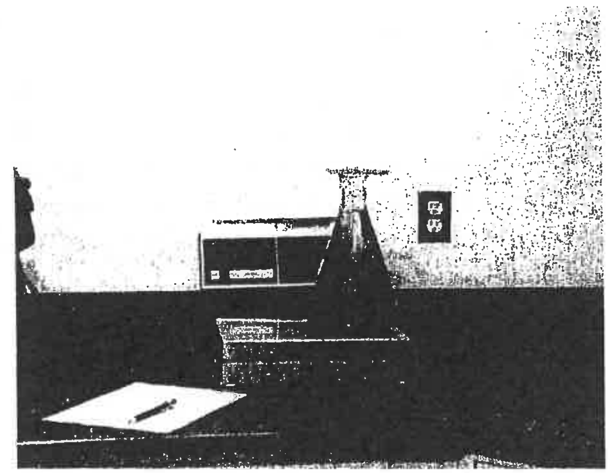
13. Fill a small beaker with water and use it to top off the water in each flask. Slide the cover plate over the top of the flask just as the water reaches the top.



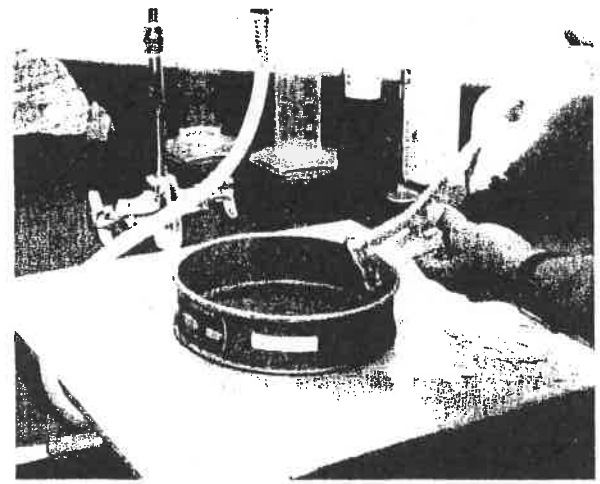
14. While holding the cover plate in place, carefully dry the flask and cover plate.



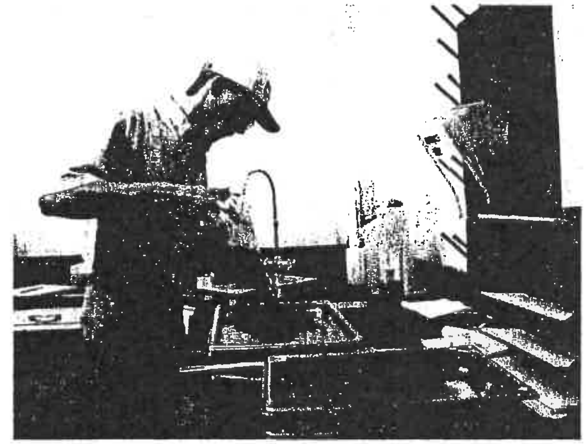
15. Determine the weight of each filled flask 10 ± 1 minutes after the vacuum has been released.



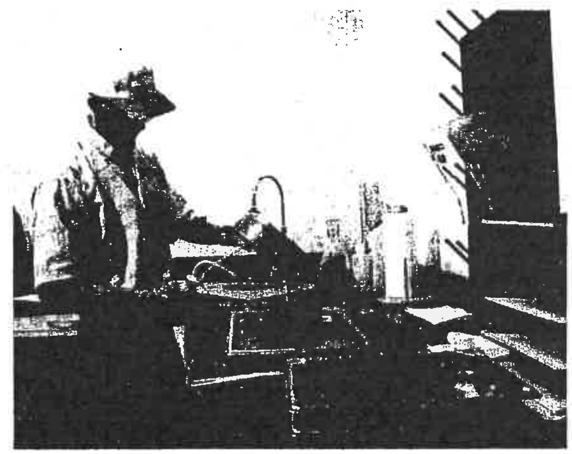
16. Drain the water from the flasks over a 75 μm (No. 200) sieve.



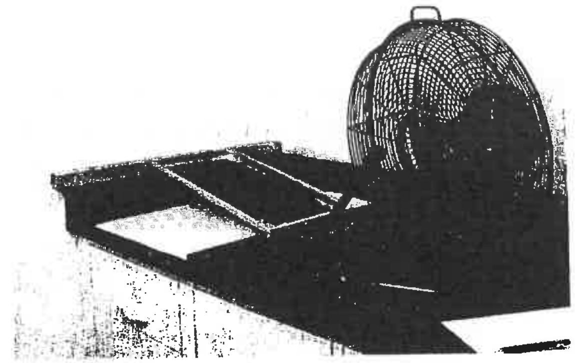
17. Empty as much of the mix as possible onto a large, flat, clean pan. (Make sure you get a tare weight of the pan.) Wash the remaining mix in the flask out and into the sieve. Make sure all of the mix has been washed out of the flask.



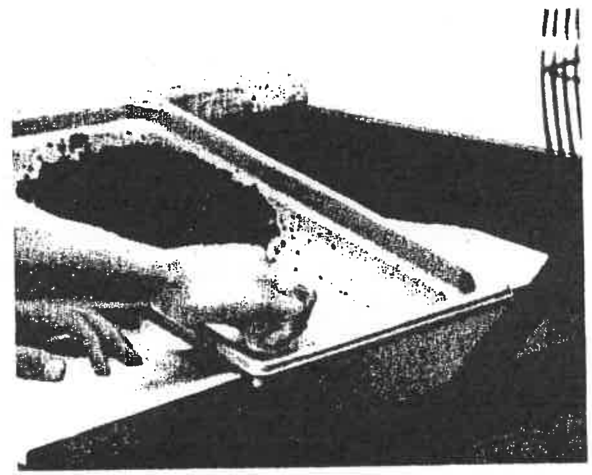
18. Rinse any of the mix on the sieve onto the mix in the pan.



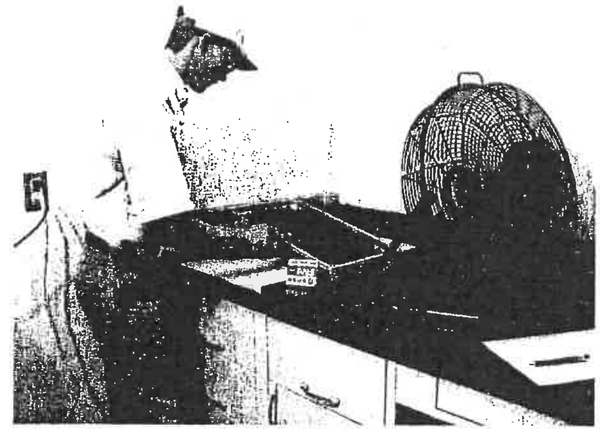
19. Place the pan in front of a fan so that it is slightly tilted.



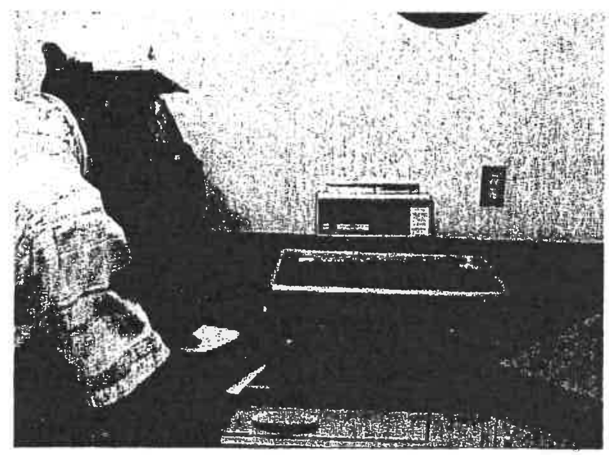
20. Use a paper towel to blot as much excess water as possible. Be careful not to remove any of the mix particles.



21. Shake the pan slightly so that the mix is spread out over the entire surface and place in front of the fan to dry.



22. Set a timer for 15 minutes and press start. At about 7 minutes, stir the mix to help the drying process. At the end of 15 minutes, weigh the pan and mix. Repeat this process until the weight loss between weighings is less than 0.5 grams.



23. Use the weight minus the weight of the pan after the last step as the final surface dry weight. The next step is to calculate the maximum specific gravity of the mix. The following equation is used. If the temperature of the water in the flasks was not 77°F, use the appropriate correction factors in either Table 1 or Table 2 in the test method.

$$\text{Maximum Specific Gravity} = \left[\frac{A}{B+D-E}\right] \times \text{Multiplier}$$

Where : A = weight of sample
B = weight of sample Surface Dry
D = weight of the flask filled with water at 77°F
E = weight of the flask filled with water and sample at 77°F

24. This calculation is made for both flasks. The final maximum specific gravity is the average of these two results. If the results of the values from the two flasks do not vary by more than 0.011 the test is considered a good test. If the results vary more than 0.011 the first step is to check your calculations. If they check, then the test will have to be rerun with new mix.

Example Problem

Given the following data - compute the maximum specific gravity of a mix:

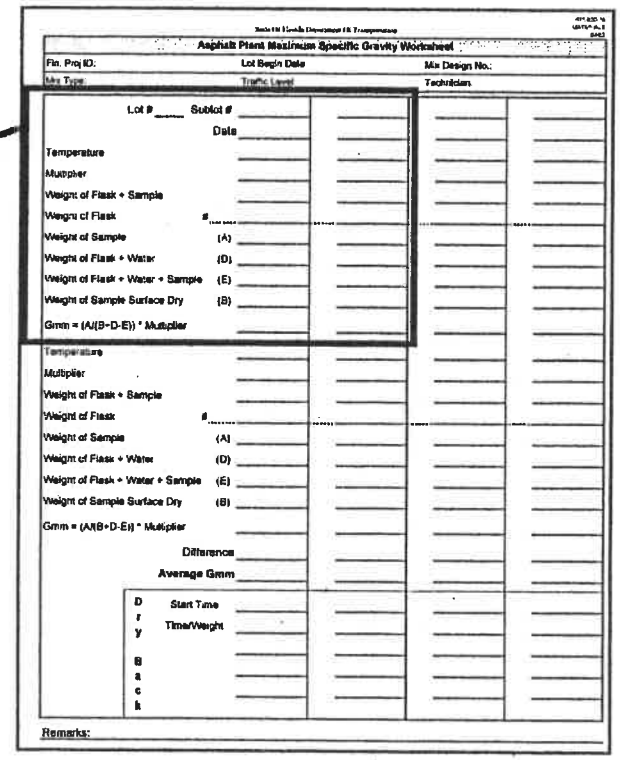
Weight of flask filled with water and sample - 2,620 g
Dry weight - 1,050 g
Surface dry mass - 1,060 g
Weight of flask filled with water at 77°F - 2,000 g

Therefore: A = 1,050 g
B = 1,060 g
D = 2,000 g
E = 2,620 g

$$Maximum\ Specific\ Gravity = [\frac{A}{B+D-E}] = [\frac{1,050}{1,060 + 2,000 - 2,620}] = 2.386$$

or, using an excerpt from the Asphalt Plant Maximum Specific Gravity Worksheet

Lot # ____ Sublot #			
Date			
Temperature		77°	
Multiplier			
Weight of Flask + Sample			
Weight of Flask	#		.....
Weight of Sample	(A)	1,050 g	
Weight of Flask + Water	(D)	2,000 g	
Weight of Flask + Water + Sample	(E)	2,620 g	
Weight of Sample Surface Dry	(B)	1,060 g	
Gmm = (A/(B+D-E)) * Multiplier		2.386	



QUIZ

1. The sample size added to each flask is ______________________________.

2. Before the sample is added to the flask, it needs to be:

   ___ a. warmed, broken into conglomerates no larger than 1/4 inch, then cooled to room temperature.
   ___ b. warmed, broken into conglomerates no larger than 1/2 inch, then cooled to room temperature.
   ___ c. used as-is.
   ___ d. warmed, broken into conglomerates no larger than 1/4 inch, then it is immediately added to the flask.

3. The sample is added to the flask and the flask is ______________________________
____

4. A partial vacuum pressure of ______________ is applied to the flask.

5. Once the vacuum pressure is released, the flask is:

   a. ______________________________ and
   b. ______________________________

6. Given the following data, compute the maximum specific gravity of a mix:

   Weight of flask filled with water at 77°F - 2,000 g
   Dry weight - 1,000 g
   Surface dry mass - 1,020 g
   Weight of flask filled with water and sample - 2,610 g

7. If a maximum specific gravity test is conducted where the result from flask 1 is 2.505 and the result from flask 2 is 2.405, the test results are ______________________________.

Answers are listed on page 8-21.

ANSWERS TO QUESTIONS

<u>Page 8-6</u>

1. 10 kg
2. 0.1 mm
3. to prevent moisture from being pulled into the vacuum
4. to clean out the pans

<u>Page 8-19</u>

1. 1,000 to 1,100 g
2. a.
3. Shaken vigorously until the sample moves freely inside the container
4. 30 ± 2 mm Hg
5. a. slowly filled with water
   b. the temperature of the water is determined
6. 2.439
7. Unacceptable - the difference is more than 0.011

CHAPTER NINE

Review Quiz

Things which you learned in this course are going to help you do a better job as an Inspector. This Review Quiz is designed to help you know how well you have learned. It is also designed to prepare you for the Examination.

Listed below are instructions on how to take the quiz.

1. Do not take this quiz immediately after you finish Chapter Eight of the Course.
2. Do not cram the night before you take the quiz. Remember that the objective is not to test your memory. The objective is to help you evaluate how well you have learned the material and how well you can think through your everyday work problems.
3. When you take this quiz, make sure that you will not be disturbed for about an hour and a half.
4. Attempt all questions.
5. You may refer to the course material if you get stuck on a question. But first try to reason out the problem.
6. Finally, keep track of your wrong answers. Instructions on how to grade yourself follow the Review Quiz. If you score less than 90% on the quiz, do not be disappointed. Go back and study the course materials once again and re-attempt the quiz.

GOOD LUCK

REVIEW QUIZ

1. The two components of asphalt concrete are:

   a. ____________________

   b. ____________________

2. Which of the following is (are) fine aggregate?

   ___ A. Slag
   ___ B. Sand
   ___ C. Gravel

3. Which of the following may <u>not</u> properly be included in an overall description of sampling?

   ___ A. Handling samples carefully to avoid contaminating them, changing their properties or losing material
   ___ B. Obtaining representative portions of the proper size
   ___ C. Extracting asphalt cement from aggregates
   ___ D. Observing the proper methods for locating and removing samples

4. What is the proper container for samples of asphalt cement? ____________________

5. What should you do with certification papers that accompany loads of liquid bituminous material? ____________________

6. When sampling from stockpiles, how many locations should you sample? ____________________

7. Should these locations be in a vertical line? ____________________

8. When obtaining a stockpile sample, first clean away the ________________ aggregates, then sample from the ____________ area.

9. In order to sample aggregates from a truck, you must dig ________________ across the load. These should be at least ____________ below the surface of the aggregates at the sides of the load.

10. How many places should you sample along the bottom of each trench? ______

11. Which sampling procedure for obtaining a shovelful of aggregates is better?

___ A. Pushing the shovel downward into aggregates
___ B. Scraping the surface of the aggregates horizontally

12. Should the samples from different hot bins be combined into one bucket? ______

13. How much material should you remove from each hot bin in relation to the amount needed for testing? ________ ____

14. Which of the following best describes when you should obtain check samples of asphalt cement in relation to the test samples?

___ A. From the third of the load following the test sample third
___ B. Right after obtaining the test sample
___ C. At least five minutes after the test samples

15. Before drawing off a sample of asphalt cement from the spigot, you should draw off and discard at least ______ _________ of the material to ensure a representative sample.

16. How should aggregate samples be reduced in size? ________________________________

17. Which of the following give inaccurate gradation test results?

___ A. Dusty scale weighing pan
___ B. Scale out of balance
___ C. Dirty sieves
___ D. Spilling the sample
___ E. Losing dust from the sample
___ F. Losing one pebble from the sample

18. Standard sieve sizes are designated in ______________, while alternate designations are in ____________ and ___________________________.

19. Is minus 3/8-inch (9.5 mm) material coarser than the openings of a 3/8-inch (9.5 mm) sieve? ________________

20. All minus No. 8 (2.36 mm) material can be considered __________ aggregate.

21. How many openings are in 3 linear inches of a No. 4 sieve? __________

22. What two types of sieves are used in gradation tests?

a. ____
b. ____

23. Aggregates should be dried, to a constant weight, in ovens capable of maintaining a uniform temperature of______ ________.

24. Aggregate samples sieved on 12-inch (300 mm) sieves should be weighed to the nearest __________.

25. Mineral filler samples should be weighed to the nearest __________.

26. Using the information below, complete the gradation worksheet.

You are testing sample number 5 of Grade 67 aggregates from a stockpile. The test sample weighs 2,191.1 g. No aggregates are retained on the 3/4-inch (19.0 mm) sieve. On the 1/2 inch (12.5 mm) sieve, 467 g of material is retained. Thereafter, cumulative weights of 1,216.0; 1,520.1; 1,830.2; 1,945.3; 2,050.7; 2,100.9; 2,120.4; 2,130.9 and 2,191.1 g are obtained.

ORIGINAL DRY WEIGHT ____________________

TYPE MATERIAL ____________________

SAMPLE NUMBER ____________________

SIEVE SIZE		CUMULATIVE WEIGHT (g)	TOTAL % RETAINED	TOTAL % PASSING
19.0 mm	(3/4")			
12.5 mm	(1/2")			
9.5 mm	(3/8")			
4.75 mm	(#4)			
2.36 mm	(#8)			
1.18 mm	(#16)			
600 μm	(#30)			
300 μm	(#50)			
150 μm	(#100)			
75 μm	(#200)			
-75 μm pan	(-200)			

27. Why are fine aggregate samples washed before being sieved? ______________________________
____

28. Washed samples are decanted over a ________ (No. _____) sieve and a ________(No. _____) sieve.

29. How long do you wash a sample? ______________________________________

30. The minimum weight of a mineral filler test sample should be ___________. Should mineral filler samples be washed before being tested? ___________

31. The results of gradation tests on hot bin samples are used to determine the___________________________ of aggregates needed from each bin to achieve a combined aggregate mixture that compares favorably with the _____ ____________.

32. When sieving manually, move the stacked sieves both ____________________ and ____________________ using a ____________________ action to keep the aggregates moving continuously over the sieves.

33. How much should the composite samples of hot mix weigh? ______________________________

34. Should hot mix be sampled only after it has cooled for an hour? ___________

35. Should you use the same size test sample for all types of hot mix? ___________

36. After quartering a sample the second time, what should you do with each pair of quarters? _____________________
____

37. What should be done with the two sample boxes of hot mix? ______________________________
____

38. During the extraction test, the ignition oven is preheated to ___________________.

39. If the sample and sample basket assembly weighs 2950 grams and the basket assembly weighs 1775 grams, what is the weight of the HMA sample? ____________________

40. The weight of the extracted aggregate sample was 782.4 g. The dried weight of the aggregate after washing was 708.3 g. After running the gradation test, 7.5 g of material passed the No. 200 sieve.
What was the total weight of minus No. 200 material? ________________
What was the percent of material passing the No. 200 sieve? ________________

41. Core samples are tested to determine the ____________ for Superpave mixes.

42. Should cores be dried to a constant weight in an oven prior to determining the weight in air? ________________

43. What would happen to a core if you dropped and bent it? ____

44. A ___________ and _____________ are suspended through the scale or balance and into a container of water.

45. Before weighing anything for a core density test, you should tare the scale:

___ A. with the wire and basket suspended in air.
___ B. without the wire and basket.
___ C. with the wire and basket suspended in water.

46. Should the water level be held constant from one test to the next? _________

47. What should be the temperature of the water bath? __________________

48. Where is the lab density found? ______________________

49. Complete all remaining blanks on the Asphalt Pavement Density Test worksheet shown here, using the data provided. Then compare your calculations with the answer sheet.

Lot No:		Sublot No:		Check One ☐ Roadway Core ☐ SGC Pill			
Date Produced	Sample Number	Lane No.	Station Number	A Dry Weight	B SSD Weight	C Weight in Water	A/B-C Gmb
	1		25+25	660.1	725.3	425.6	
	2		213+04	639.6	729.1	430.1	

50. Given the following data: Weight of flask filled with water and sample - 2,770 g
Dry weight - 1,175 g
Surface dry mass - 1,192 g
Weight of flask filled with water at 77°F - 2,140 g

What is the maximum specific gravity of the mix? ________________

51. If a maximum specific gravity test is conducted where the result from flask 1 is 2.325 and the result from flask 2 is 2.301, the test results are ____.

Now, to grade yourself on the Review Quiz, total your incorrect answers. There are about 105 answers in the quiz.

If you scored less than 90% -- that's more than 10 incorrect answers -- go back and study the parts of the course that gave you trouble. Then, take the Review Quiz again. When you can answer the Review Quiz questions correctly, you will have no trouble with the Examination.

ANSWERS TO QUESTIONS

1. a. Aggregates
   b. Asphalt cement
2. B
3. C
4. One-liter (quart) friction-top cans
5. Collect and submit with daily reports to project office
6. Three (at least)
7. No, staggered
8. Slope, flat (level)
9. trenches, one foot
10. Seven
11. A
12. No
13. Three or four times the amount
14. B
15. Four liters (one gallon)
16. By splitting them in a mechanical splitter
17. All of them
18. millimeters, inches, openings per inch
19. No, finer
20 Fine
21. Twelve
22. a. (200 mm) 8-inch round
    b. (300 mm) 12-inch round
23. 230 ± 9°F
24. 0.1 g
25. 0.1 g

26. Original Dry Weight 2,191 grams
Type Material Grade 67 aggregate
Sample Number 5

SIEVE SIZE	CUMULATIVE WEIGHT (g)	TOTAL % RETAINED	TOTAL % PASSING
19.0 mm (3/4")	0	0	100
12.5 mm (1/2")	467.0	21.3	78.7
9.5 mm (3/8")	1216.0	55.5	44.5
4.75 mm (#4)	1520.1	69.4	30.6
2.36 mm (#8)	1830.2	85.5	15.5
1.18 mm (#16)	1945.3	88.8	11.2
600 μm (#30)	2050.7	93.6	6.4
300 μm (#50)	2100.9	95.8	4.2
150 μm (#100)	2120.4	96.7	3.3
75 μm (#200)	2130.9	97.2	2.8
-75 μm pan (-200)	2191.1	100	0

27. To help determine the total amount of minus 200 (75 μm) material
28. 2.36 mm (No. 8), 75 μm (No. 200)
29. Until the wash water runs clear
30. 100 grams, yes
31. proportions, mix design
32. laterally, vertically, jarring
33. About 35 pounds
34. No
35. No

36. Place in a sample box
37. Retain in case referee analysis is needed
38. 1000°F
39. 1175 grams
40. 81.6 g; 10.43%
41. density
42. No, in a cool place
43. Its density would change
44. Wire, basket
45. C
46. Yes
47. 77°F ± 2°F
48. Mix Design
49.

Lot No:		Sublot No:		Check One ☐ Roadway Core ☐ SGC Pill			
Date Produced	Sample Number	Lane No.	Station Number	A Dry Weight	B SSD Weight	C Weight in Water	A/B-C Gmb
	1		25+25	660.1	725.3	425.6	2.203
	2		213+04	639.6	729.1	430.1	2.139

50. 2.091
51. unacceptable, the difference is more that 0.011.