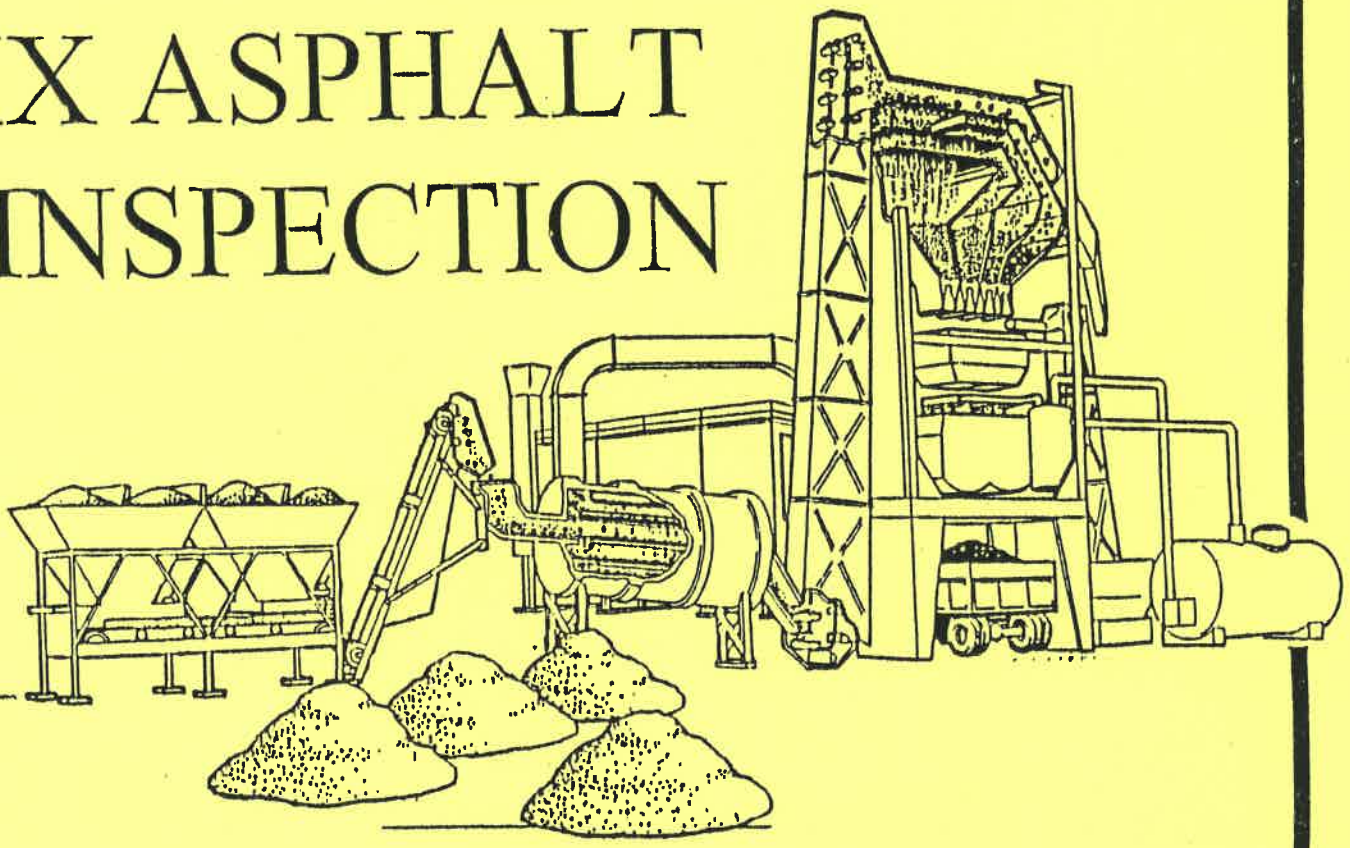
Florida Department of Transportation

HOT MIX ASPHALT PLANT INSPECTION



HOT MIX ASPHALT PLANT INSPECTION

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

Hot Mix Asphalt (HMA) Plant Inspection is a self-instructional training course that covers the activities required to inspect HMA plants. The major areas covered in this course include:

- Equipment Familiarization;
- Materials Acceptance and Control;
- Inspection of the Equipment;
- Inspection of Plant Operations; and
- Documentation.

All of the above areas are discussed in terms of the technician's responsibilities, but this does not mean that only one person will perform all the activities. Staffing may vary according to project size and other factors, but each technician or group of technicians should be able to do all work activities.

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

It is suggested that prior to taking this course, that you take: Construction Math and Contract plan Reading. For Hot Mix Asphalt Plant Inspection, you will need both. In addition, you should have completed Hot Mix Asphalt Testing or know the subject matter thoroughly.

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 Hot Mix Asphalt Plant Inspection.

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

Hot Mix Asphalt and Plant Operations

CONTENTS

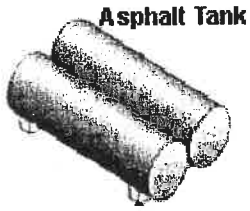
HOT MIX ASPHALT AND PLANT OPERATIONS

This is the introductory chapter. It covers basic plant operations -- but not inspection procedures. We'll discuss hot mix asphalt -- what it's made of and how it is made.

HOT MIX ASPHALT

Hot Mix Asphalt is a mixture of two things.

1. Aggregate 

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 asphalt together.

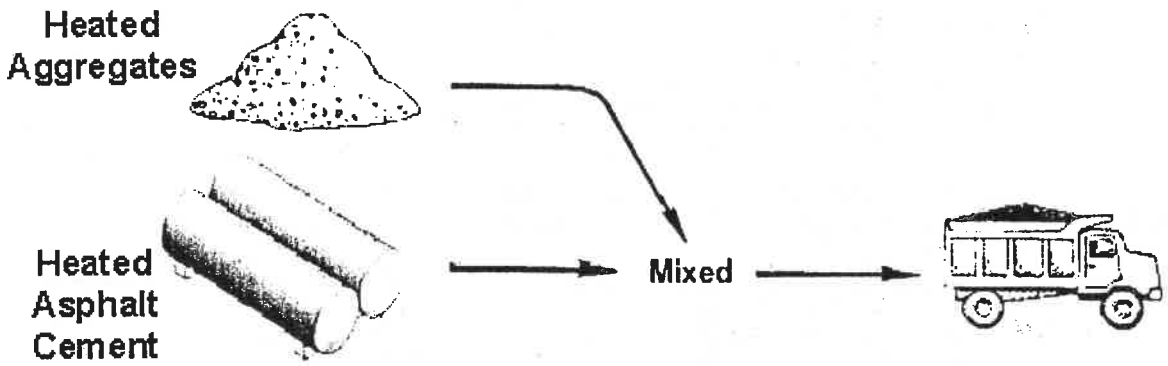
Note that there are differences between "asphalt," "asphalt cement" and "asphaltic concrete". Asphalt cement is one of the many forms of asphalt. Other forms of asphalt -- such as liquid asphalts -- are used to seal road surfaces.

Types of Asphalt Cements

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

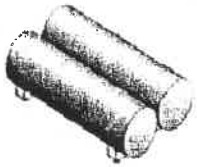
HOT MIX ASPHALT

The aggregates and the asphalt cement usually are 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 is _____.

3. Sand and stone are two commonly used _____ in hot mix.

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

See page 1-22 for answers.

HMA PLANT OPERATIONS

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

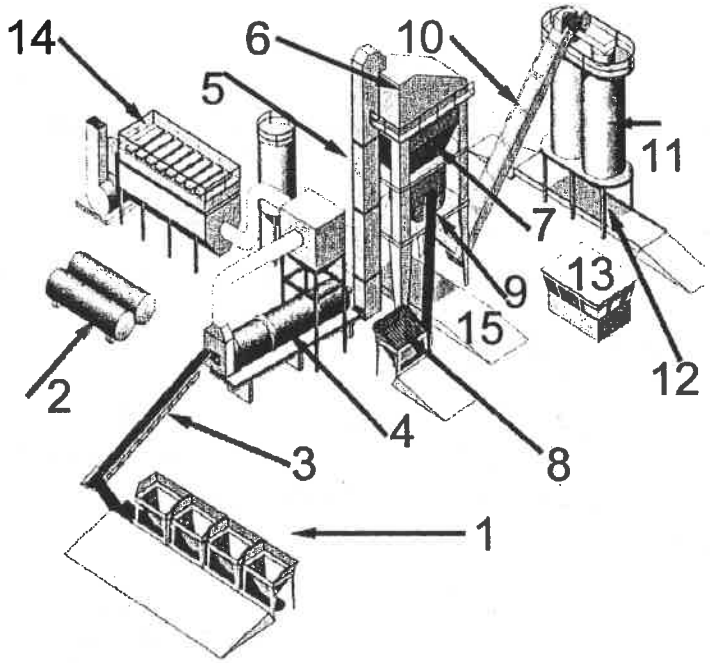
1. Proper storage and handling of HMA component materials.
2. Accurate proportioning and feeding of the cold aggregate to the dryer.
3. Effective drying and heating of the aggregate.
4. Efficient control and collection of the dust from the dryer.
5. Proper proportioning, feeding and mixing of the asphalt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

There are two kinds of asphalt concrete plants in general use: batch and drum-mix plants. Batch plants mix HMA by placing the right quantities of aggregate, fillers and asphalt cement in a mixer and mixing one "batch" at a time. Drum-mix plants operate without batching units, keeping constant the flow of aggregate, fillers, asphalt cement and mixed to produce asphalt concrete. We will discuss batch plants in this section and drum-mix plants later. 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 (CTQP).

BATCH PLANT OPERATIONS

BASIC PROCESS

A diagram showing the basic parts of a 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 or mixing chamber where the heated aggregate and asphalt cement are mixed. Typical batch quantities range from 3,000 to 10,000 pounds.



The following paragraph describes the basic process by which material flows through a batch plant.

The aggregate is first stockpiled and then moved to the cold feed bins (1) which hold each of the aggregate sizes 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 onto a screen deck (6) where it is separated into the various sizes that will be used in the production of HMA. If recycled asphalt pavement (RAP) is included in HMA mixture, it is fed from a RAP cold feed bin (8) and conveyed directly into the weigh hopper just above the pugmill (9). The various sizes of aggregate are stored in hot bins (7). They are combined with the asphalt cement and mixed in the pugmill (9). After they are mixed, they can be fed up a conveyor belt (10) to the hot storage silos (or bins) (11) or it can be loaded directly into a truck (15). The completed HMA mixture is loaded into delivery trucks at an area below the storage silos (12). The plant operation is controlled from a control house (13). The

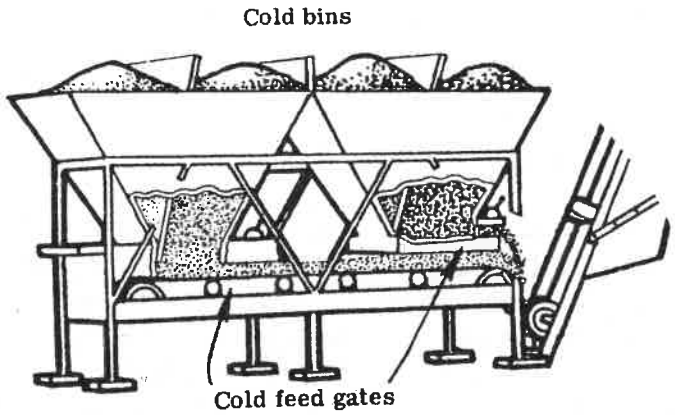
plant is also provided with an air pollution control system (14) which in this diagram is a baghouse.

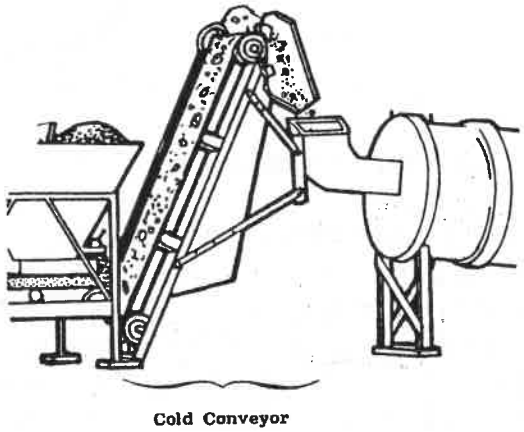
AGGREGATE

Eleven of the fourteen major parts are used for preparing aggregate. The eleven parts are discussed below.

Cold Bins, Cold Feed Gates, and Belt Feeders (1) & (3)

Fine and coarse aggregate are stockpiled separately. The aggregate in each stockpile (except natural sand) have been crushed and screened to take out oversized and undersized rocks. The aggregate from each stockpile are placed into a separate cold bin. The cold bins supply aggregate to the cold conveyor.





To see what happens to the aggregate in a batch plant, start with the cold feed and cold conveyor. The belt feeder is the piece of equipment which transports the cold aggregates from the cold bins to the cold conveyor. The aggregates are fed out of adjustable feeder gates at the bottoms of the cold bins. The feeder gates are individually set along with the speed of the feeder belt underneath each cold bin to deliver the proper proportions of different size aggregate to the cold conveyor.

now, you should know that dust-filled hot gases are drawn from the dryer to the bag house. In the bag house, the gases are drawn through a series of cloth bags on which the dust particles are collected. This filtering process cleans the gases of dust that would otherwise pollute the air. The collected dust particles are typically returned to the aggregate at the hot elevator -- but they may be diverted and wasted.

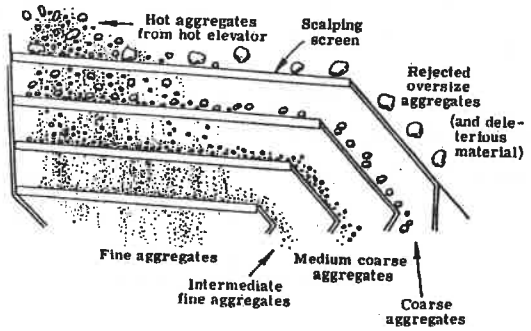
Wet collection systems -- wet washers -- collect the dust in a different way. The dust-laden gases are forced through water spray where they are dampened. As the dust particles become heavy with moisture, they fall and collect at the bottom of the washer. They are drained off as sludge and wasted. Wet collection systems cannot return the dust to the aggregate to be used in the mix.

Exhaust Stack

After the dust collector removes the dust particles, the gases are drawn by an exhaust fan. The exhaust fan discharges gases -- but not dust -- into the air through the exhaust stack.

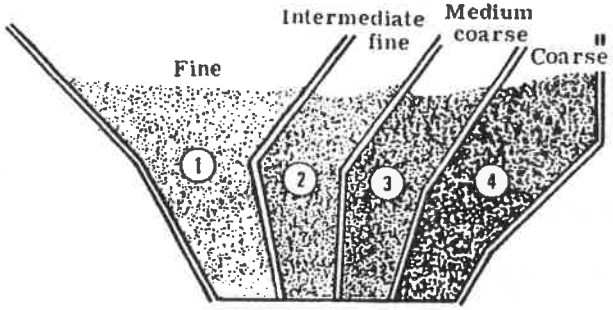
Screen Deck Unit (6)

The screen deck unit is a combination of different sized screens that separate the aggregate into the number of sizes available in the HMA plant. Oversized aggregate and material -- such as roots, bags etc. -- are rejected by the scalping screen and discarded through the scalping chute.



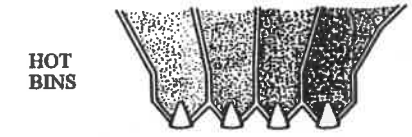
Hot Bins (7)

The hot bins temporarily store the hot aggregate. In practice, each hot bin is referred to by a number. Fine material passes through the screens first and goes into Bin No. 1. The coarsest aggregates are carried farthest over the screens and are deposited in the last bin -- number 4



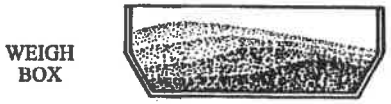
Weigh Box

The weigh box (also called a weigh hopper) is where the correct bin proportions are weighed out. A weigh box is shown under the hot bins at the right.



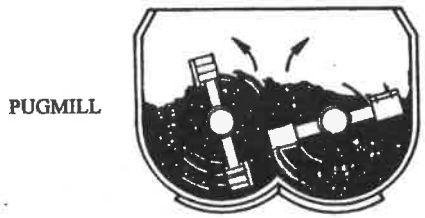
Mixing Unit -- or Pugmill (9)

Finally, there is the mixing unit to mix the aggregate and asphalt cement. A cross section of the mixing unit is shown at the right. The mixing unit is called a pugmill. The paddles mix the aggregate and asphalt cement by turning in opposite directions, as shown in the diagram.



Storage Silo (11)

The storage silo is optional on batch plants. It is used to temporarily store HMA until it is hauled to the construction site. The HMA can be loaded into the delivery trucks either directly from the pugmill or from the storage silo.



ASPHALT CEMENT

To see what happens to asphalt cement at a batch plant, start with the hot asphalt cement storage.

Asphalt Cement Storage (2)

The asphalt cement is maintained in a heated state in a storage tank. From the hot storage, the asphalt cement is pumped through a pipe to the weigh bucket.

Weigh Bucket

In a weigh bucket a certain amount of asphalt cement is weighed out for each batch of hot mix. Don't confuse "weigh bucket" with "weigh box". The weigh "box" is where the aggregate are weighed. The weigh "bucket" is where the asphalt cement is weighed. After the asphalt cement is weighed, it is discharged from the weigh bucket into the mixing unit -- or pugmill -- through a spray bar.

Mixing Unit -- or Pugmill (9)

The mixing unit -- or pugmill mixes the asphalt cement with the aggregate already in the pugmill. All the ingredients -- aggregate and asphalt cement -- are mixed for a specified time. The result is hot mix asphalt. The hot mix is then discharged from the pugmill into a truck or into a storage silo.

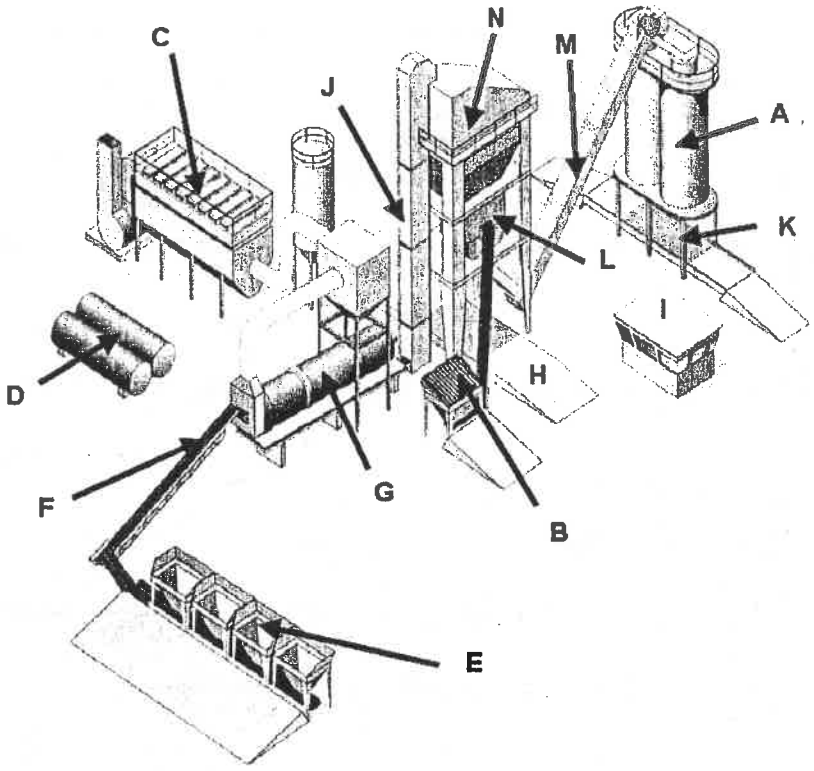
SUMMARY

The hot mix produced at one time from measured amounts of aggregate, and asphalt cement is called a "batch." Familiar? A batch plant measures, mixes and discharges hot mix in individual batches.

QUIZ

1. Go through the plant diagram and indicate the various parts of the plant by filling in the appropriate blanks.

A. _____
B. _____
C. _____
D. _____
E. _____
F. _____
G. _____
H. _____
I. _____
J. _____
K. _____
L. _____
M. _____
N. _____



2. Cold bins are fed from the _____.

3. What kind of a plant have we been discussing? _____

4. What does the pugmill do? _____

5. Is the cold conveyor called "cold" because the aggregate has not been heated? _____

6. The cold conveyor moves the aggregate into the _____.

7. The hot gases leaving the _____ pass through the _____.

8. Is the dust collected and then shot into the air along with the gases? _____

9. The hot elevator and hot bins are so called because they carry and store the _____ aggregate.

10. What is the purpose of the storage silo? _____

11. Are the aggregate from the stockpiles placed in the same bin?_____

12. Does the hot elevator carry the aggregate to the dryer? _____

13. After screening, the aggregate is deposited in the _____ according to particle size.

14. In a four-bin arrangement, the aggregate is divided into _____, _____, _____ and _____.

15. Amounts from each bin are measured in the _____.

16. Measured amounts of aggregates are discharged from the weigh box into the mixing unit, which is called a _____.

17. Are the aggregates fed from the stockpile into the hot elevator? _____

18. Are the aggregates tumbling through the flame in the dryer? _____

19. Are the aggregates unloaded from the hot elevator directly into the hot bins? _____

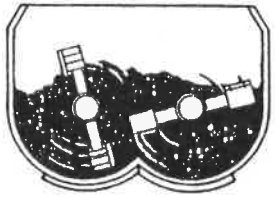
20. Does the screening unit reject oversize aggregate? _____

21. Do the finest aggregates pass through the screens first, into the bin closest to the hot elevator? _____

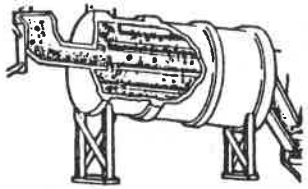
22. Does the weigh box empty into the pugmill? _____

23. Label the parts of a batch plant pictured below with the correct names from this list:

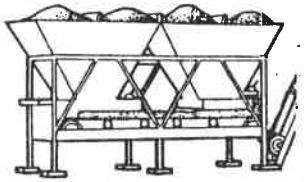
cold bins
hot asphalt cement storage
hot elevator
hot bins
dust collector
pugmill
dryer
aggregate weigh box
screening unit



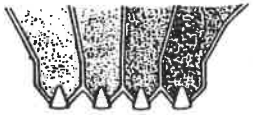
A. _____



B. _____



C. _____



D. _____

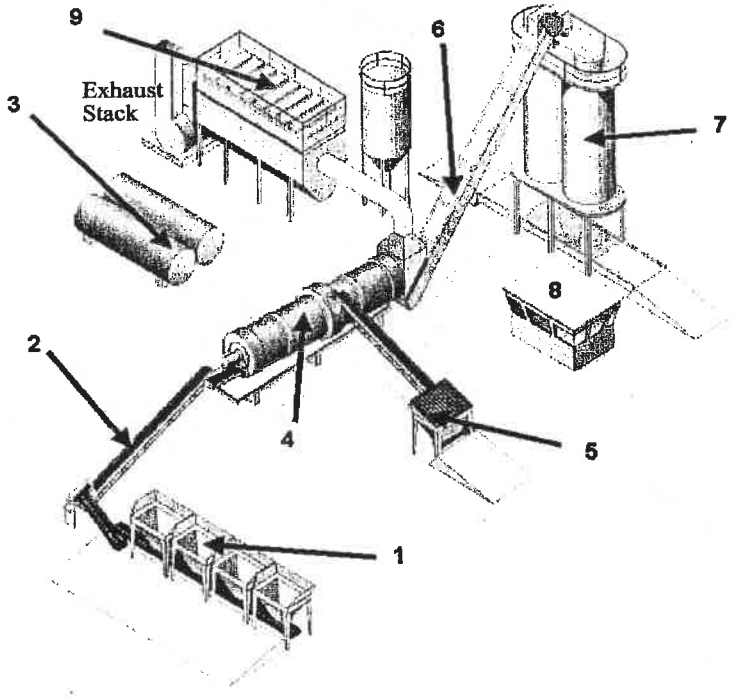
E. _____

Check your answers beginning on page 1-22.

DRUM-MIX PLANT OPERATIONS

BASIC PROCESS

The figure below shows the components 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. A drum-mix plant has no screening unit, hot bins or pugmill. Aggregate gradation is controlled at the cold bins and the drum 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 controlled gradations 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 aggregate 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).

BASIC PARTS

Cold Bins (1)

The cold aggregate bins in the drum-mix plant are similar to those of a batch plant. The only significant difference is that the gradation of the aggregate in the bins must be more carefully controlled because the aggregates are not screened later in the process to remove oversized material and re-separate the different gradations.

Aggregate Feed Gates and Belts

The feed gates and belts are similar to those of a batch plant, but they play a more important role. They control the gradation of aggregate in a drum-mix plant. They must be accurately adjusted to achieve the desired mix design.

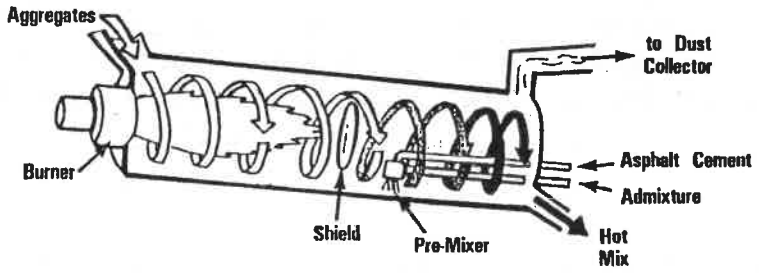
Aggregate Conveyor (2)

The aggregate conveyor in a drum-mix plant performs the same function as the cold feed conveyor in a batch plant -- it carries the aggregate from the cold bins to the drum-mixer.

Drum-Mixer (4)

The drum-mixer is similar in appearance to the dryer in a batch plant, but it not only heats the aggregate, it also mixes all the materials.

The aggregate enters at the upper end of the drum-mixer. The burner is at the upper end on a parallel flow drum and at the lower end in a counter flow drum. The aggregate is heated and dried in much the same manner as in a batch plant dryer.



The major difference lies in the other end of the drum where the asphalt cement is sprayed onto and mixed with the aggregate. This mixing process is carried out continuously rather than in batches. In some counter flow plants, the aggregate is heated in an inner drum and mixed with hot asphalt cement in an outer drum. In other plants, the aggregate is in the drum and then conveyed to another piece of equipment called a coater where the asphalt cement is added and mixed with the aggregate.

Dust Collector (9) and Exhaust Stack

The dust collector and its exhaust stack in a drum-mix plant carry out the same function as they do in a batch plant, removing fines to minimize air pollution.

Hot Asphalt Storage (3)

The hot asphalt cement storage tank performs the same heating and storage function as in a batch plant. The key difference is that the asphalt cement is pumped and measured continuously into the drum where it is mixed with the hot aggregate. So there's no asphalt weigh bucket (just as there is no weigh box for the aggregate).

Hot Mix Elevator (6) and Silo (7)

From the drum-mixer, the blended hot mix is discharged into the hot mix elevator and carried up into the hot mix silo where it is stored until it is discharged into haul trucks.

Asphalt Cement Liquid Additive

Although not shown in the typical drum-mix plant illustration, some mention should be made of where and how asphalt cement liquid additive is added. If the asphalt cement liquid additive is used, it is measured, added and thoroughly mixed with the asphalt cement before it enters the drum. Generally this is done at the refinery, but in some cases, this is done at the HMA plant.

QUIZ

1. Go through the plant diagram and indicate the various parts of the plant by filling in the appropriate blanks.

A. _____

B. _____

C. _____

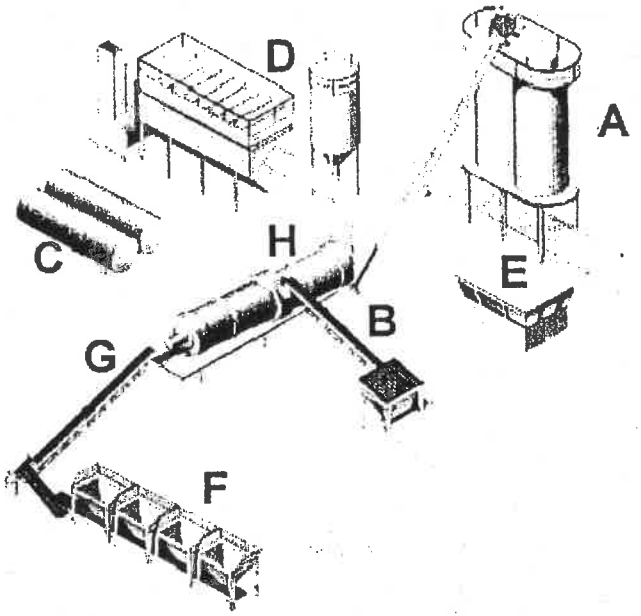
D. _____

E. _____

F. _____

G. _____

H. _____



2. Which of the parts meters the quantity of aggregate for compliance with the mix design? _____

3. Which part removes fines in order to minimize air pollution? _____

4. At what location is the aggregate heated? _____

5. At what location is the aggregate and asphalt cement mixed together in a parallel flow drum mix plant?

_____

6. Which of the following parts might be found on a batch plant but not on a drum-mix plant? (Circle one or more)

A. cold aggregate feed gates
B. gradation screens
C. dust collector
D. hot aggregate bins
E. pugmill
F. mineral filler storage bin or silo
G. asphalt weigh bucket

Check your answers beginning on page 1-23.

If you need to review the basic parts of hot mix asphalt plants, do it now. When you know this chapter well, go on to Chapter Two, MATERIALS.

ANSWERS TO QUESTIONS

Page 1-5

1. a. aggregate
   b. asphalt cement
2. asphalt cement
3. aggregates
4. fine, coarse

Page 1-13 thru 1-15

1. A. Hot storage silos
   B. RAP Feeder bins
   C. Pollution control system
   D. Asphalt storage tanks
   E. Cold feed bin
   F. Cold feed conveyor
   G. Dryer
   H. Truck loading ramp for pugmill
   I. Control room
   J. Hot Elevator
   K. Truck loading ramp for storage silos
   L. Weigh Box
   M. Conveyor belt
   N. Screen deck
2. stockpiles
3. batch plant
4. It mixes the aggregate and asphalt cement
5. Yes
6. dryer
7. dryer, dust collector

8. No
9. hot
10. Temporary storage of HMA
11. No, separate bins
12. No, to the screening unit
13. hot bins
14. fine, small, medium, coarse
15. weigh box
16. pugmill
17. No, into the cold bins
18. Yes
19. No, they are screened first
20. Yes
21. Yes
22. Yes
23. A. Pugmill
    B. Dryer
    C. Cold bins
    D. Hot bins
    E. Aggregate weight box

Page 1-20 thru 1-21

1. A. Storage silo
   B. RAP feeder
   C. Asphalt Storage
   D. Dust collection system
   E. Control house
   F. Cold bins
   G. Cold feed conveyor
   H. Dryer/mixer
2. Cold bin feeders

3. Dust collector
4. High end of drum
5. Low end of drum in a parallel flow plant
6. B. Gradation screens
   D. Hot aggregate bins
   E. Pugmill
   G. Asphalt weight bucket

CHAPTER TWO

Materials

CONTENTS

MATERIALS

In this section, we will discuss aggregate, reclaimed asphalt pavement (RAP), mineral filler, and asphalt cement as they relate to each of your responsibilities as a Plant Technician.

INTRODUCTION: USES AND CHARACTERISTICS OF HOT MIX ASPHALT

PAVEMENT COURSES

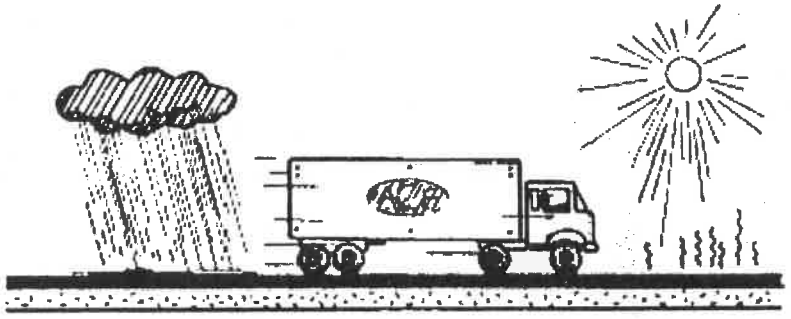
Hot mix asphalt can be used for different pavement courses: base, structural and friction courses. The list below shows the asphalt mixes and their uses.

Asphalt Mix Type	Use
FC-5	Friction course (Open-graded)
FC-9.5	Friction course (Dense-graded)
FC-12.5 (FC-6)	Friction course (Dense-graded)
SP-9.5	Structural course
SP-12.5	Structural course
SP-19.0	Structural course
B-12.5	Base course

For each course, the required aggregate sizes will be different. The asphalt* content required will also vary.

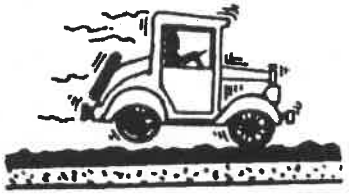
* From here on, we will refer to asphalt cement as "asphalt."

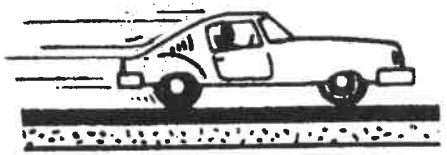
All pavement courses must be strong and stable, holding in place under traffic loads. In addition, the friction course must be highly durable to withstand the wearing effects of traffic and weather and provide skid resistance, especially in wet weather.



It is important for a friction course to have a smooth surface. Surface texture affects such things as wear on tires, skid resistance, and a comfortable ride.

Friction course mixes are made from materials that are angular, have good surface texture, and are resistant to polishing -- which offer good skid resistance.





Cold Conveyer (3)

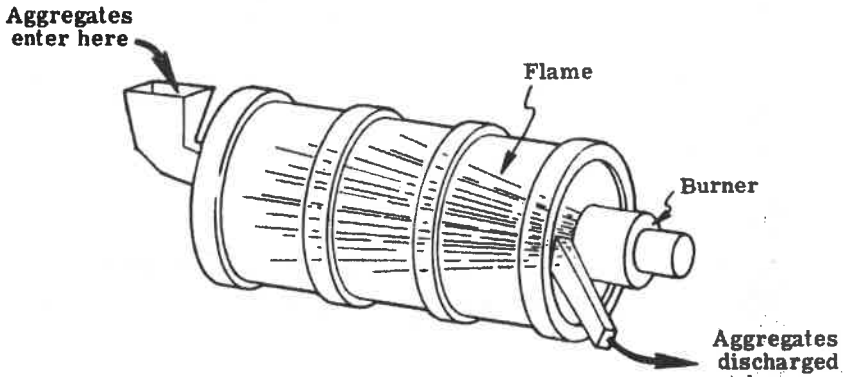
The cold conveyor moves the cold aggregate to the dryer.

RAP Feeder Bin (8)

If RAP (Reclaimed Asphalt Paving) is to be used in the mix it is placed in the RAP feeder bin where it is conveyed directly into the weigh hopper.

Dryer (4)

The dryer heats and dries the aggregate as they pass through the flame of the burner.



DRYER

Dust Collector (14)

A dust collector is connected to the dryer. It does just what its name indicates. It removes the dust from the hot gases coming from the dryer and from other points in the system where dust might escape into the atmosphere. There are two basic types of dust collection systems -- dry and wet. The dry system is by far the most common since it allows the collected dust to be returned to the mixture.

A typical dry dust collector is the bag house collector. We will discuss bag house dust collectors in detail later but, for

AGGREGATE GRADATION

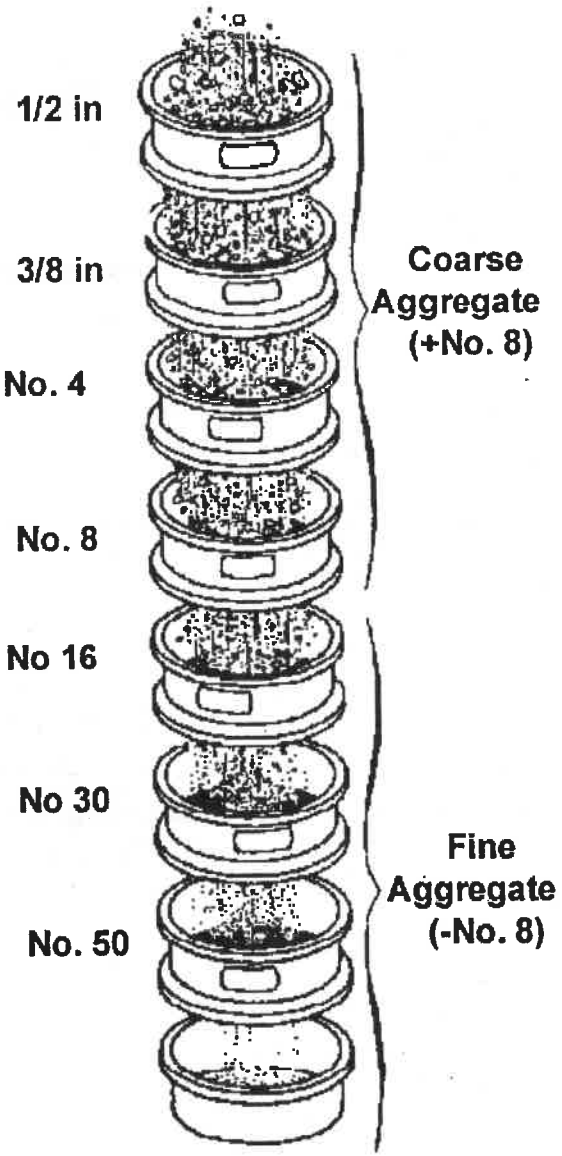
The particle sizes in the aggregate materials and the proportion of each size to be used in the mix are set by specifications. The range and relative distribution of particle sizes are known as the GRADATION. This is an important definition and one you should remember.

Gradation is determined by sieving. Sieving means putting the aggregate through a series of sieves having different-size openings as shown here on the right. The sieves at the top have large openings, the ones at the bottom small openings.

The range of particle sizes goes from the coarsest sieve size on which aggregate is retained to the finest. The break between coarse and fine is the No. 8 sieve. Aggregate retained on the No. 8 sieve are considered coarse -- and are called plus-eight. Aggregate passing through is considered fine -- and are called minus-eight. The relative distribution refers to the percentage of each particle size in the total material.

Gradation requirements give the percentages that must pass various sieve sizes.

Requirements for aggregate gradation vary with the type of mixture. Mixtures vary according to the pavement course in which they are being used.



QUIZ

1. Is durability the ability to withstand the effects of traffic and weather? _____

2. Why do friction courses require angular material that are polish resistant and have good surface texture?

   _____

3. The range and relative distribution of particle sizes in the aggregate material are called _____.

4. Can gradation requirements be different for each type of mix? _____

5. You determine the gradation of aggregate by _____.

See page 2-30 to check your answers.

AGGREGATE STRENGTH

Hot mix asphalt is designed to provide a satisfactory pavement for the traffic to which it will be exposed. The quality of the pavement depends on many things. One of these is aggregate strength. The aggregate must be hard, durable, and preferably angular shaped so that they will interlock to provide strength to the mixture.

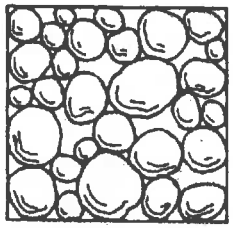
AGGREGATE SPECIFIC GRAVITY AND ABSORPTION

The specific gravity of the aggregate should be known to design a good hot mix. The aggregate specific gravity is used to calculate the voids between the aggregate particle in a hot mix asphalt. Aggregate with high absorption may be difficult to dry and may result in a loss in durability. The specific gravity is defined as the ratio of weight of the material being tested to that of an equal volume of water. When a material has a specific gravity of 2.5 that means that it weighs 2.5 times as much as an equal volume of water. The unit weight of water is 62.4 pounds per cubic foot.

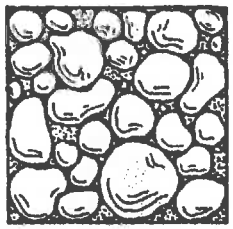
Aggregate absorption refers to the amount of water the aggregate will absorb when soaked in water. The absorption is determined after the aggregate has been thoroughly soaked for a period of time and the surface has been dried (this is referred to as the saturated-surface-dry (SSD) condition). Aggregate that has a high absorption may be difficult to dry during construction.

QUIZ

1. Will the aggregate in Figure 1 provide stronger support than the aggregate in Figure 2 ? _____



1



2

2. Does the type and shape of aggregate determine the strength of the hot mix?_____

3. If a material has a specific gravity of 2.0, is it heavier or lighter than an equal volume of water? _____

4. To calculate the specific gravity of a material, you can divide the weight of one cubic meter (foot) of the material by the weight of one cubic meter (foot) of _____.

5. What is the unit weight of water? _____

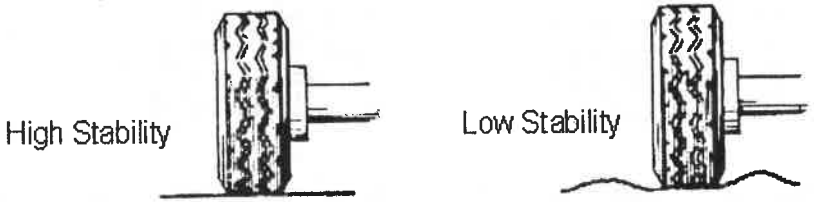
6. Specific gravity is the ratio of the weight of a certain volume of material to the weight of an _____ volume of water.

7. If a core sample weighs 460.2 g and an equal volume of water weighs 210.9 g, the specific gravity of the core sample is _____.

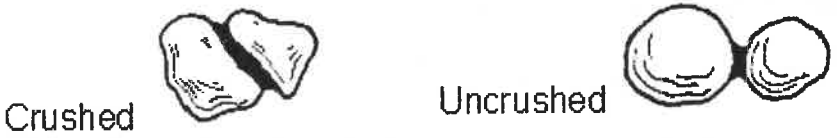
See page 2-30 to check your answers. If you answered all the questions correctly, go on to the next page. If you made mistakes, review the last two pages before going on.

PAVEMENT STABILITY

The gradation of the aggregate and the asphalt content of the mix greatly affect pavement stability. Stability is the resistance to displacement caused by loading. Displacement causes rutting.



Crushed particles add to the stability of a mix because of interlocking between the crushed faces. They also provide more surface area for the asphalt to stick to, binding the particles together.



The stability value of each mix is highest at one particular asphalt content. If you do not use enough asphalt, it cannot bind the aggregate particles together. If you use too much, it over-lubricates and pushes the particles apart.

Asphalt is a durable binder that holds the aggregate together. This helps to maintain the stability of the pavement. Asphalt also gives flexibility to the pavement that aggregate itself can't provide. Flexibility is the ability of a pavement to adjust to settlement without cracking.

QUIZ

1. Is higher stability provided by uncrushed aggregate or crushed aggregate? _____

2. Do asphalt coatings form better bonds between crushed aggregate or uncrushed aggregate? _____

3. Can more asphalt than the specified percentage make a pavement less stable? _____

4. Flexibility in a pavement is primarily due to its _____ content.

5. Can you distinguish between the three properties? Match the terms with the definitions.

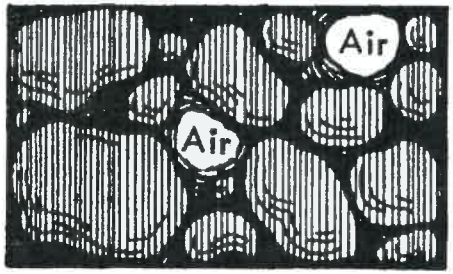
1. Durability	_____ Ability to resist displacement caused by loading
2. Flexibility	_____ Ability to withstand effects of weather and traffic
3. Stability	_____ Ability to adjust to settlement without cracking

See page 2-30 to check your answers.

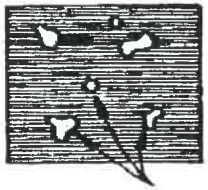
VOIDS

Properties of hot mix asphalt are affected by voids in the mix.

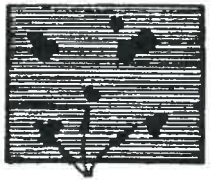
Some of the voids in the mineral aggregate are filled with asphalt. This not only improves some qualities of the mix, but also ensures that aggregate particles are well coated.



When fine aggregate or mineral filler and asphalt are added to the coarse aggregate fraction, air voids are filled but the total volume may not be changed. If too much fines or too much asphalt is added, then the volume must increase.

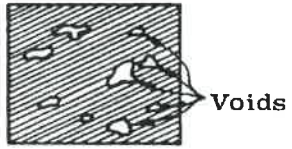


Voids

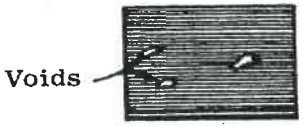


Fines and Asphalt

The number of voids remaining is reduced when the mix is compacted. Compaction compresses the mixture, squeezing air out. Compaction also reduces the volume of the mixture.



Before compaction

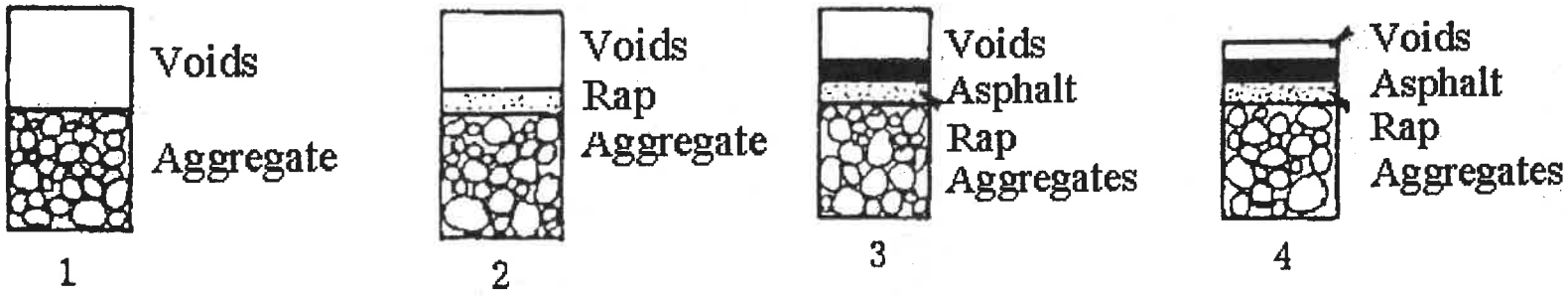


After compaction

Even after compaction, there must always be some voids remaining in the mix. Voids equaling approximately six or seven percent of the volume of the mix are desirable on the roadway. (Mixes typically are designed with three to five percent voids in laboratory compacted samples. In the field, sufficient density is obtained to provide approximately six or seven percent voids in place. The required void level varies with type of mix placed.) There are two reasons for this. First, asphalt cement expands during hot weather. If there is no room within the mix for this expansion, the asphalt is forced to "bleed" -- or ooze out onto the surface of the pavement. A second reason for leaving some voids in the compacted mix is to allow for additional compaction due to traffic. However, if the voids are too high, the pavement will age prematurely, which will adversely affect performance.

QUIZ

These diagrams picture the reduction of voids in the mix.



1. In figure 1, aggregate occupies much of the volume but there are many _____ left.
2. In figure 2, the number of voids is reduced by the addition of _____.
3. In figure 3, part of the remaining voids are filled with _____.
4. In figure 4, the voids are further reduced by _____.
5. Should there be voids in the compacted hot mix? _____
6. If yes, approximately how many?
   In lab compacted samples? _____
   In field compacted samples? _____

See page 2-30 to check your answers.

AGGREGATE

Let's talk about aggregate in detail. We will see how they should be stockpiled and approved for use at the plant. Your job as a Plant Technician is important here.

STOCKPILES AND STOCKPILING METHODS

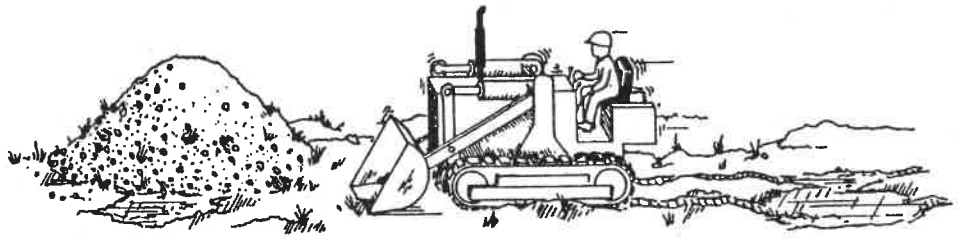
Aggregate and RAP are brought to the plant and stockpiled. Stockpiles are simply storage piles where supplies of aggregate are kept. Plant Technicians must check stockpiles and stockpiling methods to make sure that a consistent product is provided.

The quality of the stockpile is affected by stockpiling methods.

Contamination

Stockpiles should be placed on hard, well-drained ground that has been cleared of foreign matter that might contaminate the aggregate. Stockpiling on a paved surface is a very good procedure. Stockpiles should be free of objectionable material such as vegetation, sod clumps, clay and rejected mix. A ground cover of at least six inches of aggregate should be maintained to prevent contamination when the underlying surface is not paved. If the surface is paved, no minimum cover is necessary.

For example, bulldozers can mess up a stockpile. A dozer can dig up sod and vegetation and carry sticky clay on its blade and tracks. If it does, those materials end up in the stockpile and they contaminate the mix.



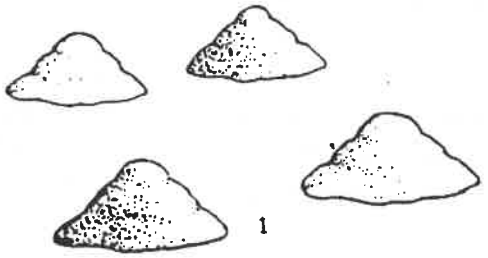
The stockpile above is a mess. We hope you never see one like it. If you ever find contaminated stockpiles or bad stockpiling practices, see that corrective action is taken immediately. Report bad stockpiling practices to your supervisor and also notify the Contractor.

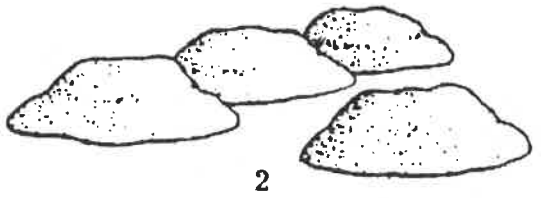
Segregation

Stockpile gradations should be uniform. That is, the different aggregate should be distributed evenly throughout the stockpile. To minimize segregation, it is good to use aggregate stockpiles that have been screened into a small range of sizes. If the stockpile is not formed properly, the aggregate tends to segregate or separate in various particle sizes. Badly segregated stockpiles can have a very detrimental impact on the quality of the hot mix asphalt.

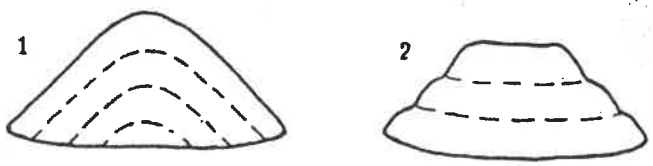
Various things can be done to minimize segregation. Truckloads of aggregate should be spotted close together over the stockpile area. If a bulldozer is used to build the stockpile, the dozer should deposit the aggregate so that the pile builds up in layers of uniform thickness. Each layer should be less than four feet (1.2 m) thick. In general, aggregate should be deposited in ways that will prevent coning -- and they should not be dumped, cast or pushed over the sides of the stockpiles.

QUIZ





1. Which figure shows the better method of spotting truckloads of aggregate over the stockpile area? _____



2. Which figure shows the better method of building a stockpile? _____

3. Does uniform gradation in the stockpile help provide a continuous supply of the different aggregate sizes? _____

See page 2-30 to check your answers.

Separate Stockpiles

Different aggregate, including RAP materials must be stockpiled separately -- and the stockpiles must be placed so that they won't mix together. One method is placing them a sufficient distance apart. Another way is to place bulkheads or solid partitions between the stockpiles. The bulkheads must be long enough and high enough to keep the aggregate separated.

Mixed stockpiles are regarded as contaminated -- and the contaminated portions of the stockpiles must be removed, otherwise, the final mix will have too much variability in the aggregate gradation.

Each aggregate stockpile must be identified. A sign placed on the pile must show aggregate size, source and mix type. An alternate to the sign is a map displayed in the field lab.

Excessive Moisture

Moisture in the stockpile can be a problem -- if there is too much of it. Of course the dryer can take care of some moisture. But after heavy rains or long periods of damp weather, stockpile moisture might be more than the dryer can handle at the normal production rate. In this case, the production rate is reduced to give the aggregate more time in the dryer. The contractor can minimize the problem by building stockpiles that drain freely and by working the dryer portion of the stockpile when it is wet. This problem is worse when aggregate with high absorption values are used.

Degradation

Degradation occurs when the stockpiled aggregate is broken or crushed by bulldozers or other heavy equipment. Stockpiling practices which result in excessive degradation should not be allowed.

Later in this section, you will learn how to check for excessive degradation.

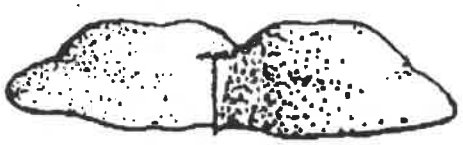
QUIZ

1. Stockpiles with different aggregate sizes are placed correctly in figure _____.

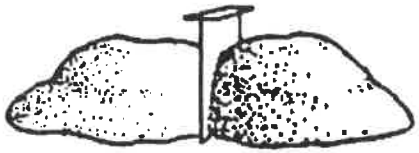
1

2

2. The proper use of a bulkhead is shown in figure _____.



1



2

3. Coning a stockpile causes the aggregate to become _____.

4. What takes place when stockpiled aggregate is fractured under the weight of heavy equipment? _____

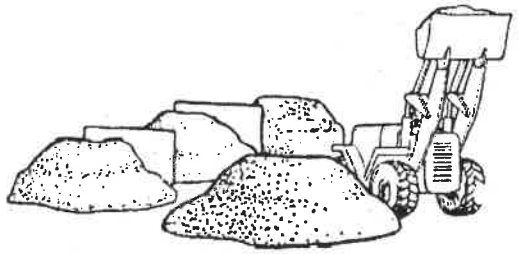
See page 2-30 to check your answers.

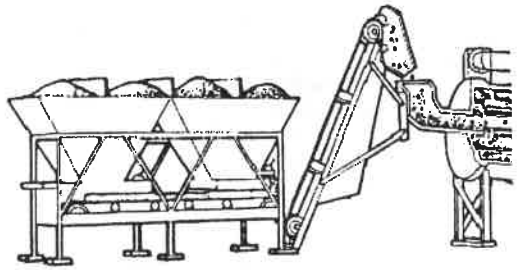
SUMMARY

The operation below is ideal. The important points are noted.

The stockpiles are well separated so that they are not contaminated.

The front-end loader picks up the aggregate in place, which avoids degradation and contamination.





The stockpiles are not coned or segregated.

Many times, aggregate from two stockpiles -- coarse and intermediate -- are blended to form a coarse mixture. Intermediate aggregate is the finer portion of coarse aggregate.

If you ensure that all of these points are followed, stockpiling and blending aggregate will occur without problems.

RECLAIMED ASPHALT PAVEMENT (RAP)

Using recycled HMA is now common practice. The RAP is collected in stockpiles to be used in recycled HMA. The RAP should be handled like an aggregate, however, it must be remembered that the RAP also includes a significant amount of asphalt cement. The procedures recommended for aggregate stockpiles should be followed for RAP.

When RAP is used, the oversize material must be removed prior to feeding into the HMA plant or the oversize material must be further crushed to provide a satisfactory size. The oversize material can not be heated throughout when fed into the plant and if used, will result in an uneven surface when placed and compacted.

The RAP is not fed into the dryer in a batch plant since this will cause overheating of the asphalt cement and excessive smoke. Instead, for a batch plant, the RAP is typically fed into the weigh box where it is then batched into the mix. In this case, the aggregate must be heated to a higher temperature, so that the resulting mix temperature is satisfactory.

In a parallel flow drum mix plant, the RAP is added about midway down the drum mixer where it is mixed with the new aggregate and new asphalt cement. In a counter flow drum mix plant, the RAP can be added in the outer drum or in a coater.

SPECIAL INFORMATION ON MIX DESIGNS

Before we go on to asphalt, let's stop to say a few things about mix designs. Basically, mix designs consist of two main parts:

- the source and gradation of the supplied aggregate
- the hot mix design data.

As a Plant Technician, you should know that each material source will have a different mix design. For any job, the mix design sets forth the hot mix asphalt requirements.

A typical mix design is shown on the next page.

Please review it carefully. The first general background part contains information on the contractor and asphalt plant that the design is for at the top of the form, in the center of the form, detailed information is provided on the aggregate sources, and on the bottom of the form, the gradation for each aggregate and the job mix formula gradation.

The second part contains detailed information on the properties of the mix.

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

SUBMIT TO THE STATE MATERIALS ENGINEER, CENTRAL BITUMINOUS LABORATORY, 2006 NORTHEAST WALDO ROAD., GAINESVILLE, FLA. 32609

Contractor: Superpavers Asphalt Contracting Address: 2006 NE Waldo Road, Gainesville, Florida

Phone No.: 352-337-3100 Fax No.: 352-337-3239 E-mail: FDOT@dot.state.fl.us

Submitted By: Superpavers Asphalt Contracting Type Mix: Fine SP-12.5 Recycle Intended Use of Mix: Structural

Design Traffic Level: D Gyrations @ N des: 100

TYPE MATERIAL	F.D.O.T. CODE	PRODUCER	PIT NO.	DATE SAMPLED
1. Milled Material		222222-1-52-01 Top 2.5" NB & SB KmP. 0.000 - 3.000 / M.P. 0.000 - 1.864	Roadway	05 / 01 / 2002
2. 67 Stone	43	Superior Aggregate Company	99-111	05 / 01 / 2002
3. 89 Stone	53	Superior Aggregate Company	99-111	05 / 01 / 2002
4. Screenings	21	Superior Aggregate Company	99-111	05 / 01 / 2002
5.				
6.				

PERCENTAGE BY WEIGHT TOTAL AGGREGATE PASSING SIEVES

	Blend Number	15% 1	30% 2	40% 3	16% 4	5	6	JOB MIX FORMULA	CONTROL POINTS	RESTRICTED ZONE
SIEVE SIZES	3/4" 19.0mm	100	100	100	100			100	100	
	1/2" 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 600µm	47	3	5	48			17		19.1 - 23.1
	No. 50 300µm	28	2	3	28			10		
	No. 100 150µm	14	2	3	18			7		
	No. 200 75µm	8.0	1.0	2.0	7.0			5.0	2 - 10	
	G_{sb}	2.562	2.393	2.446	2.561			2.467		

No. 200 reflects aggregate changes expected during production.

State Materials Engineer: [signature]
Digital signature received at the State Materials Office

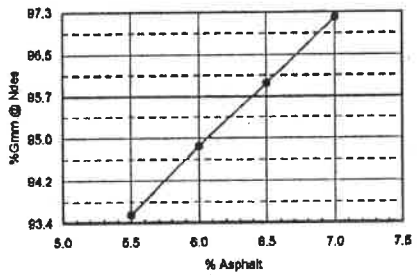
Effective Date: 07 / 23 / 2002

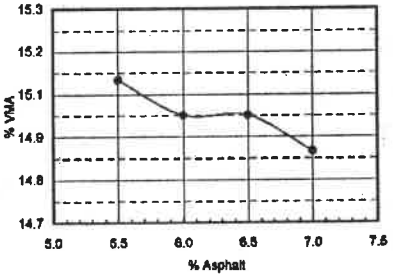
Expiration Date: 07 / 23 / 2004

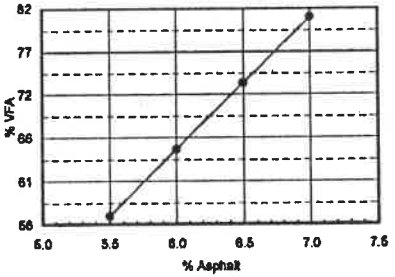
http://materials.dot.state.fl.us/fmo/Bituminous/CentralBit.ob/CentralBituminousLab.htm

HOT MIX DESIGN DATA SHEET

P_b	G_{mb} @ N_{des}	G_{mm}	V_a	VMA	VFA	$P_{0.075}/P_{be}$	%G_{mm} @ N_{ini}	%G_{mm} @ N_{max}
5.5	2.217	2.370	6.5	15.1	57	4.0	1.3	87.5	93.9
6.0	2.232	2.354	5.2	15.0	65	4.5	1.1	88.3	95.3
6.5	2.244	2.338	4.0	15.0	73	5.0	1.0	88.9	96.5
7.0	2.257	2.322	2.8	14.9	81	5.5	0.9	89.8	98.0







Optimum Asphalt 6.5 %

FAA 46 %

Mixing Temperature 300 °F 149 °C

Antistrip R-US 60-00 (D000)

Lab. Density 140.0 Lbs/Ft^3 2244 Kg/m^3

%G_{mm} @ N_{des} 96.0

Additives Antistrip 0.5 %

VMA 15.0 %

NCAT Oven Calibration Factor 0.05 % (+To Be Added)/(-To Be Subtracted)

Optimum Asphalt = 6.5%

Asphalt using 15% Milled Material @ 5.5% = 0.8%

PG 67-22 to be added = 5.7%

QUIZ

Refer to the job mix formula on pages 2-21 and 2-22 to answer the questions below.

1. The mix design is for which Contractor? _____

2. What is the intended use for this mix? _____

3. An extraction test performed on mix produced according to this mix design should reveal an asphalt content of approximately _____.

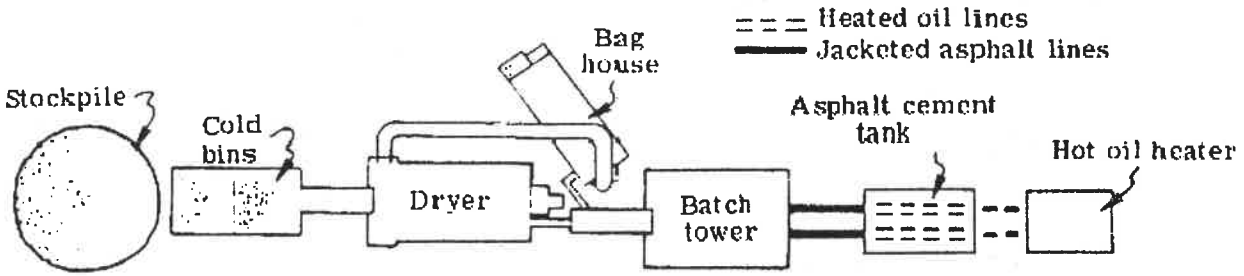
See page 2-30 to check your answers.

ASPHALT

STORING AND HEATING

All plants have at least one asphalt storage tank.

A heating system for the storage tank must effectively maintain the temperature of the asphalt. Hot oil heating systems are the most common method of maintaining the asphalt in a heated state. Other methods are acceptable, but an open flame must never come in contact with the asphalt itself. An arrangement that uses hot oil is shown below:



In the diagram above, heated oil circulates through the asphalt tank and the asphalt line jackets. The asphalt tank must be equipped with a suitable system for continuously circulating the asphalt during plant operations to assure even heating. A thermometer must be used to monitor the asphalt cement temperature.

Asphalt pipe lines and fittings are insulated to minimize heat loss. Asphalt temperature is important in the mixing operation. Any condition causing a significant variation in the asphalt temperature must be corrected by the Contractor.

CHECKING ASPHALT DELIVERY

When asphalt is delivered to the plant, you must check the accompanying paperwork to verify:

1. the certification
2. the delivery ticket
3. additives (if required)

The certification certifies that the material complies with Department specifications and that the necessary tests have been performed by the supplier. The certification is shown on the delivery ticket.

The delivery ticket contains information about the shipment:

- name of Contractor and supplier,
- grade of asphalt, and
- quantity delivered, by weight.

QUIZ

1. The plant must have at least one _____ tank.

2. The heating system of the asphalt tank must be capable of _____the asphalt temperature.

3. Which of the following is most commonly used for heating the asphalt cement in the storage tank?
   1. electricity _____
   2. hot oil _____
   3. direct flame on tank _____
   4. steam coils _____

4. A circulation system in the _____ tank assures uniform heating of the asphalt cement.

5. Asphalt in the storage tank must be maintained at the proper temperature for _____.

6. For each load of asphalt delivered to the plant, you should check the accompanying paperwork to verify:
   1. _____
   2. _____
   3. _____

7. What tells you that the material complies with Department specifications? _____

8. What document will show the quantity of asphalt delivered? _____

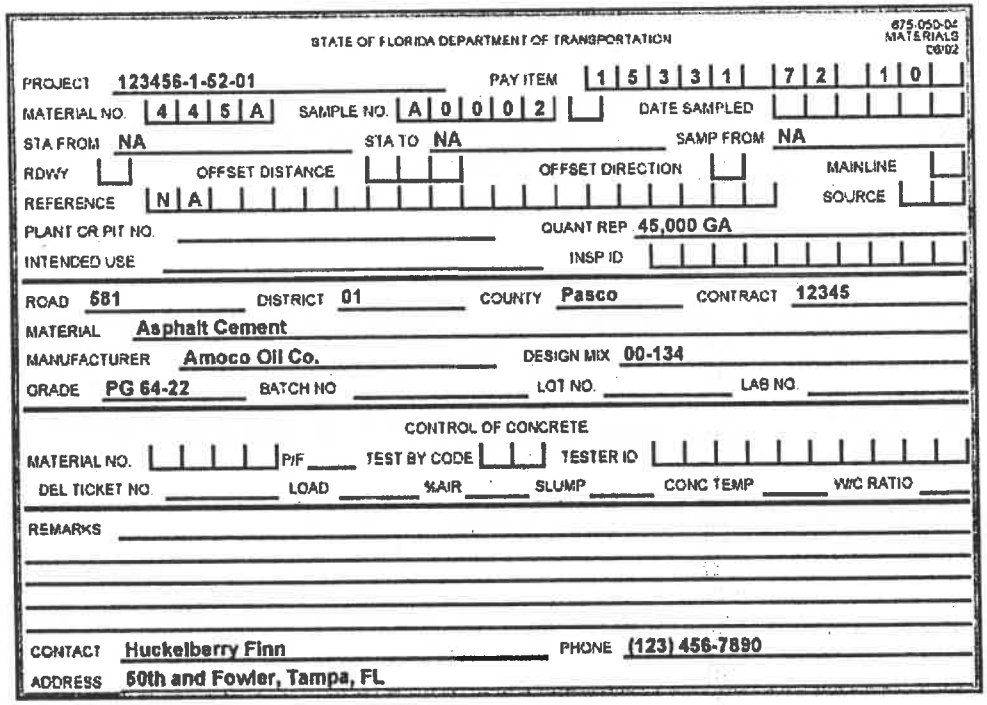
9. Is the quantity given by volume or weight? _____

See page 2-30 to check your answers.

SAMPLING ASPHALT CEMENT FROM TRANSPORTS

When asphalt is delivered to the plant, it is the Technician's responsibility to obtain samples for testing. The samples will be obtained from truck transports, so you must know how to sample from them.

You should be present when the transport arrives. Take the sample directly from the transport and submit it to the State Materials Office, accompanied by a Sample Transmittal Card (Form 675-050-04).



STATE OF FLORIDA DEPARTMENT OF TRANSPORTATION

675-050-04
MATERIALS
09/02

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

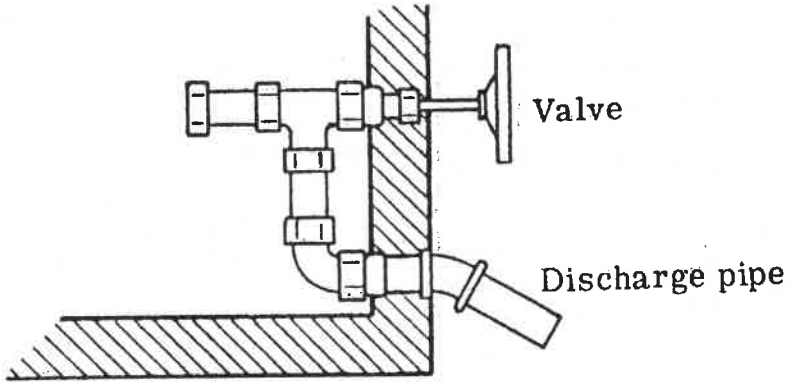
DEL TICKET NO. LOAD %AIR SLUMP CONC TEMP W/C RATIO

REMARKS

CONTACT Huckelberry Finn PHONE (123) 456-7890

ADDRESS 50th and Fowler, Tampa, FL

A sample and check sample are taken. Each must consist of one quart. Metal cans will be used. The cans must be new, clean and dry. They must be equipped with a friction lid. The transport must be equipped with a discharge pipe in the lower half of the tank, for obtaining samples.



Draw off and waste at least one gallon before taking the sample to be sure of obtaining representative material.

There are several safety issues when pumping and storing liquid asphalt. Dangerous steam can be created when hot liquid asphalt is introduced into a tank that has been empty and has accumulated moisture from condensation.

A person should never look inside a tank when it is being charged. The steam and the hydrocarbon vapor can both be dangerous to personal health and safety.

Asphalt is also HOT! CAUTION should always be used when loading, unloading, sampling, and dealing with asphalt cement.

Special first aid cards are available that show proper first aid techniques for asphalt burns.

QUIZ

1. Is an asphalt sample submitted in a half-gallon can? _____

2. May the sample container be reused? _____

3. When sampling from spigots on truck transports, allow at least _____ of asphalt to pass before taking the sample.

4. The check sample is placed in how many one-quart cans? _____

See page 2-31 to check your answers.

That's it for Chapter Two. When you are ready, begin Chapter Three -- INSPECTING BATCH PLANTS.

ANSWERS TO QUESTIONS

Page 2-5
1. Yes
2. For skid resistance
3. gradation
4. Yes
5. sieving

Page 2-7
1. No, the aggregate in figure 2 will provide more support
2. Yes
3. Heavier
4. water
5. 62.4 lb/ft^3
6. equal
7. 460.2 ÷ 210.9 = 2.18

Page 2-9
1. Crushed
2. Crushed
3. Yes
4. Asphalt
5. 3, 1, 2

Page 2-12
1. voids
2. RAP
3. asphalt
4. compaction
5. Yes
6. 3-5%, 6-7%

Page 2-15
1. 2
2. 2
3. Yes

Page 2-17
1. 1
2. 2
3. segregated
4. Degradation

Page 2-23
1. Superpave Asphalt Contracting
2. Structural course
3. 6.5%

Page 2-26
1. asphalt storage
2. maintaining
3. 2
4. storage
5. mixing
6. 1. Certification
   2. Delivery ticket

3. Additives (if needed)

7. The certification
8. Delivery ticket
9. Weight

Page 2-29

1. No, one-quart can
2. No, it must be new
3. one gallon
4. One

CHAPTER THREE

Inspecting Batch Plants

CONTENTS

INSPECTING BATCH PLANTS

INTRODUCTION

In this chapter you will learn how to inspect a typical batch plant. Later, you will cover inspection procedures for typical drum-mix plants.

It is your job as a technician to see that the plant produces high-quality hot mix asphalt (HMA). Good HMA depends on proper plant inspection as well as proper sampling and testing. For example, bad gradation test results tell you that something is wrong with plant operations (if the sample is properly taken and tested), and you should know how to identify and correct the problem.

Many things can go wrong at a hot mix plant. There are many ways to impair the quality of HMA. It's your job to see that the HMA leaves the plant in good shape. If the HMA is not of suitable quality, you will have to trace the problem back to the plant operations and get it corrected.

Note: The contractor is responsible for producing high-quality HMA and it is his responsibility to detect and correct any problems that affect the mix.

REVIEW OF BATCHING EQUIPMENT

Before learning how to inspect the plant, as a review exercise go through the plant diagram on the next page and indicate the various parts of the plant.

This sketch has parts labeled A thru N. Fill in the blanks indicating the various parts of the batch plant.

A. _____

B. _____

C. _____

D. _____

E. _____

F. _____

G. _____

H. _____

I. _____

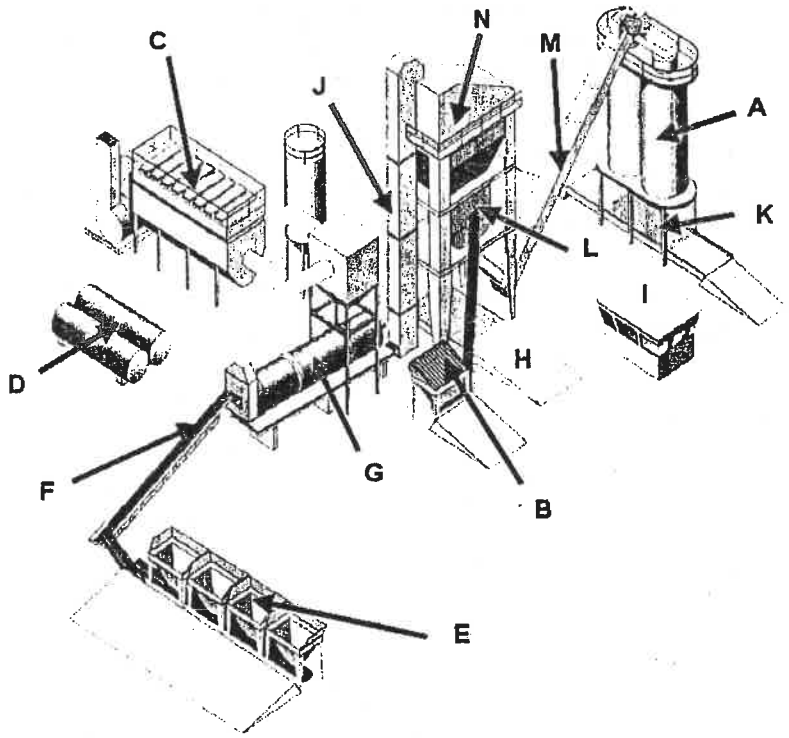
J. _____

K. _____

L. _____

M. _____

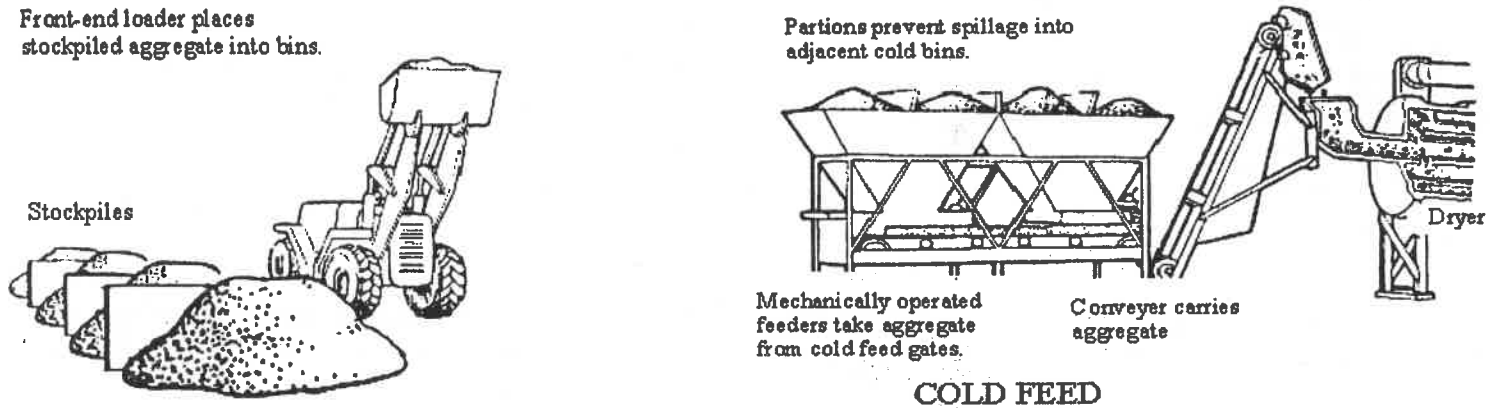
N. _____



See page 3-72 to check your answers. If you have any questions - go back to Chapter 1 and review the parts of a batch plant.

SUPPLYING COLD AGGREGATES

The cold feed -- shown below -- is the equipment which feeds the stockpiled aggregates onto the cold conveyor in route to the dryer.



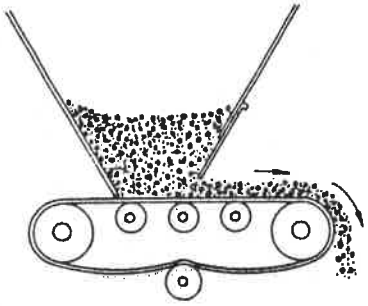
COLD FEED

The plant technicians must ensure that the entire cold feed operation runs smoothly.

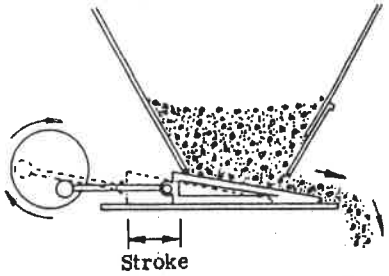
INSPECTING COLD FEED EQUIPMENT

There should be a separate cold bin for each size of stockpiled aggregates -- as shown above. The cold bins should have partitions to prevent the aggregates in one bin from spilling into an adjacent bin. The Department requires the use of mechanically operated feeders capable of feeding aggregates at uniform rates.

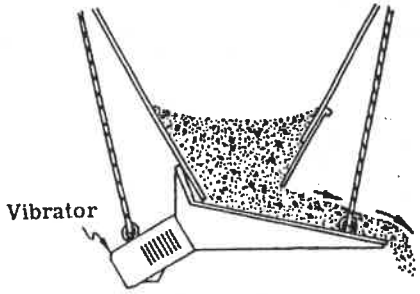
Here are three common types of mechanical feeders:



BELT FEEDER



RECIPROCATING FEEDER



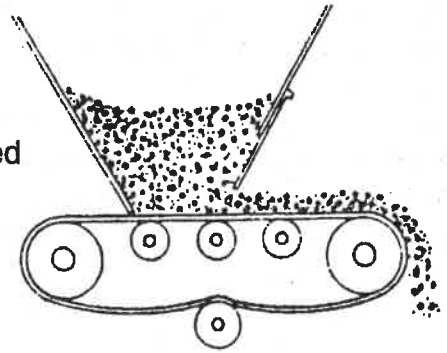
VIBRATORY FEEDER

The feeders should feed aggregates onto the cold conveyor at uniform rates. Also, the cold feed gates should be adjustable to any opening and capable of being locked into position. The belt feeder is the most common type of feeder.

CALIBRATING THE COLD FEED*

As a Qualified Plant Technician, you should know how the cold feed is calibrated properly -- so that there is a uniform flow of properly proportioned aggregates to the dryer. (The Contractor's Quality Control Technician is responsible for calibrating the cold feed.)

Remember, the cold feed should be calibrated so that each size aggregate specified in the Mix Design is fed in the right proportions. It is an easy process to verify that the contractor's calibration is accurate.



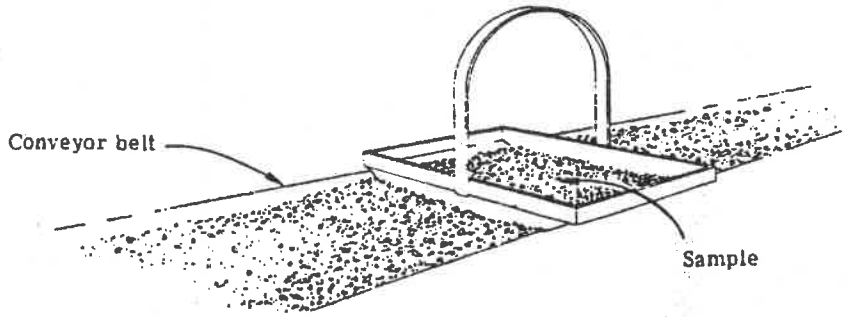
** This section addresses one method to verify calibration. Other acceptable methods can be used.*

Before the actual verification of the cold feed calibration, the following equipment should be on hand:

- shovel,
- sampling pan for each bin, and
- platform scale.

To verify the calibration of the cold feed, first all bin gates are closed and locked except the one which is to be verified. The gate is set at the desired setting by the contractor. It is a good idea to let the plant foreman do this because he is acquainted with the plant equipment and the tonnage the plant can produce. With all but one gate closed, the cold feed should be started and brought to normal operating speed, then stopped, and a sample -- aggregates from a measured section of the conveyor belt -- should be removed and placed into a tared container (bucket) and weighed.

The sample can be obtained using a sample divider or template -- as shown here:



Okay, let's assume a sample is obtained for Bin No. 1. It weighs 3.2 lbs.

Then Bin No. 2 is sampled after all other gates are closed. The sample from Bin No. 2 weighs 5.6 lbs.

The same process is repeated for the final bin -- Bin No. 3 -- and the sample weighs 7.2 lbs.

Now the total weight of all the samples is determined:

Total Weight = 3.2 lbs + 5.6 lbs + 7.2 lbs = 16.0 lbs

Okay -- now the percent weight of each sample is calculated, based on the total weight of the samples:

Bin No. 1 = (3.2 lbs)/(16.0 lbs) = 0.20 or 20%

Bin No. 2 = (5.6 lbs)/(16.0 lbs) = 0.35 or 35%

Bin No. 3 = (7.2 lbs)/(16.0 lbs) = 0.45 or 45%

The final step is to compare the calculated percentages with those on the Mix Design -- and make any necessary adjustments to the gate settings.

QUIZ

1. List the equipment needed to verify the calibration of feeder gates:

   _____

   _____

   _____

2. Who should set the feeder gates before verification of calibration? _____

3. The cold feed must deliver aggregates in accordance with the aggregate percentage listed in the _____ _____.

4. Use the data below to calculate the percentages of total aggregates from each bin:

Bin Number	Sample Weight	Total Percentage of Aggregates from Each Bin
Bin No. 1	3.3 lbs.	_____
Bin No. 2	4.9 lbs.	_____
Bin No. 3	6.8 lbs.	_____
Bin No. 4	7.9 lbs.	_____

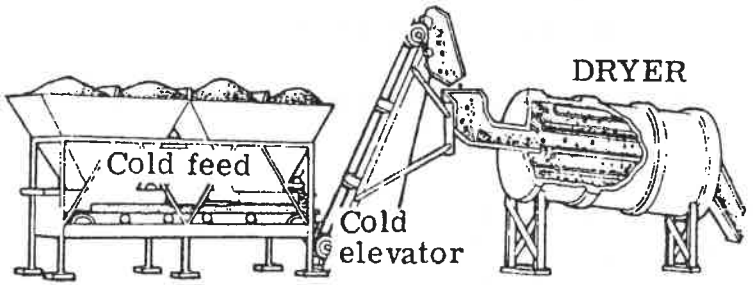
5. If the calculated percentages are not close to the percentages indicated on the _____, the equipment may need to be adjusted.

See page 3-72 to check your answers.

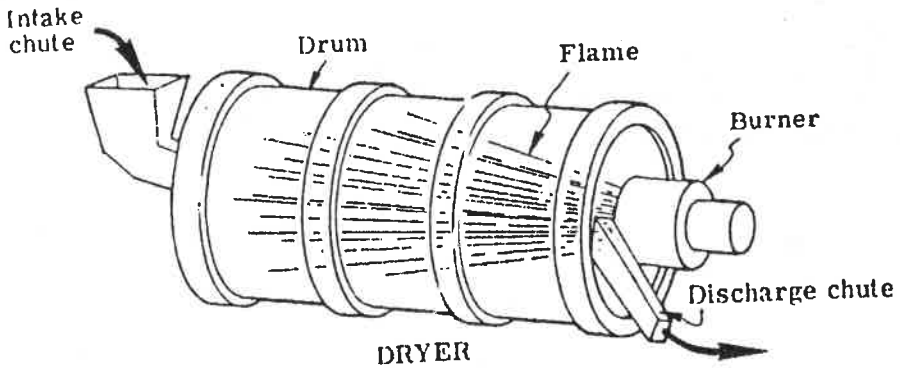
DRYING AND HEATING AGGREGATES

DRYING-HEATING PROCESS

The dryer receives cold aggregates from the cold conveyor.

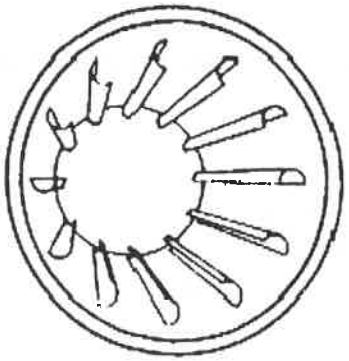
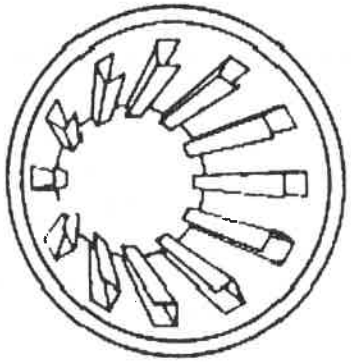


A most important factor in the operation of an asphalt plant is the ability of the dryer to dry aggregates. Moisture must be removed from the aggregates to properly coat them with asphalt. The second purpose of the dryer is to heat the aggregates to the required mixing temperature.

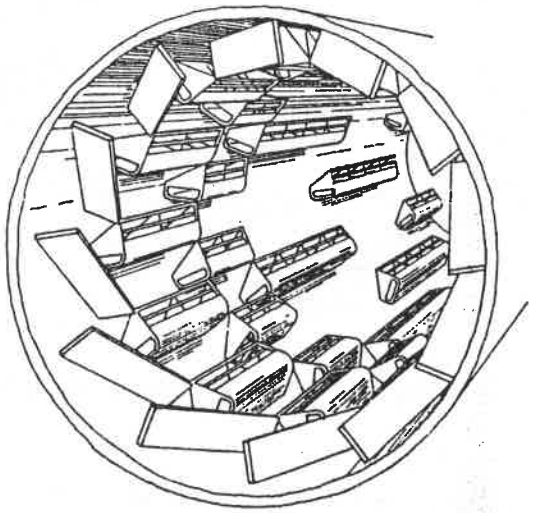


The typical dryer consists of a revolving drum with a burner placed at the discharge end.

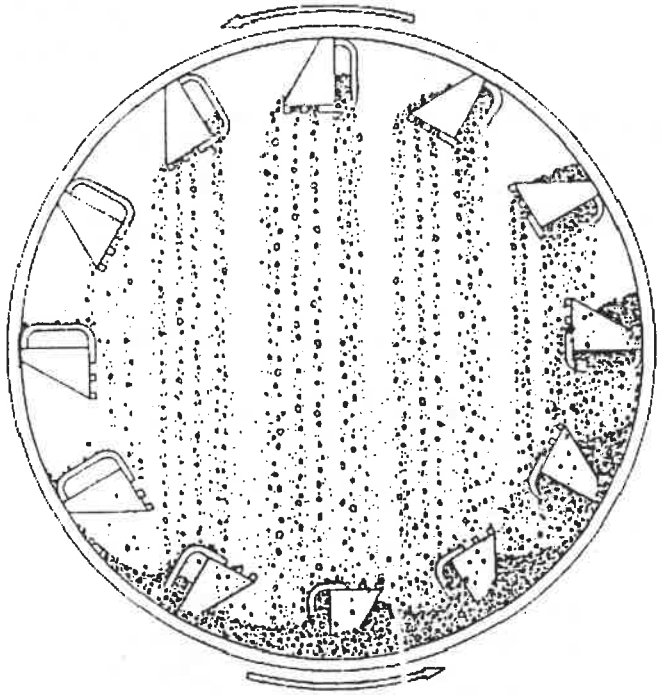
Cups or channels, called lifting flights, are attached inside the drum.

Cups   Channels

The lifting flights are of varying lengths, and are staggered along the length of the drum. Look at their arrangement.

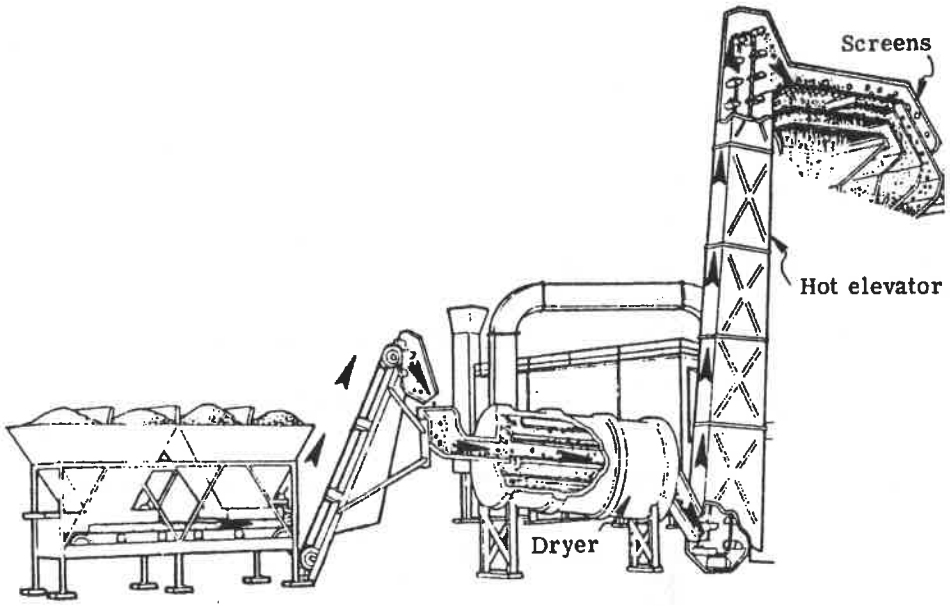


You can see from this figure how lifting flights work. As the aggregates are lifted, they are gradually spilled through the flame from the burner.



To assure even heating and thorough drying, it is important that the aggregates are fed at a uniform rate not exceeding the capacity of the dryer.

The aggregates are discharged at the burner end of the dryer where the hot elevator carries them to the screening unit.



Meanwhile, hot gases from the burner and dust from the dryer are discharged at the other end of the dryer and carried to the dust collector. We will discuss dust collectors in a minute, but first -- try the quiz on the next page.

QUIZ

1. Cold aggregates are unloaded into the intake chute on the _____.
2. To be coated with asphalt properly, the aggregates must be _____.
3. The two functions of the dryer are _____ and _____.
4. The drum is equipped with _____ which lift the aggregates as the drum revolves.
5. The aggregates are dried as they are spilled through the _____.
6. Can aggregates be completely dried if the dryer is overloaded? _____

See page 3-72 to check your answers.

DUST-COLLECTING PROCESS

The basic purpose of dust collection is to prevent air pollution by removing dust particles from the hot gases discharged from the dryer. Another purpose of dust collection -- at some plants -- is to return the dust particles to the aggregates to be used in the mix.

As we mentioned in Chapter One, there are two basic types of dust collection systems: wet and dry.

Wet Collection Systems

We discussed wet collection systems -- wet washers -- briefly in Chapter One. They consist of a cylinder into which the dust-laden gases are discharged from the dryer. The gases pass through a water spray and are dampened. As the dust particles become wet, they fall and collect at the bottom of the washer. The dirty water, which is like sludge, must be drained from the washer and wasted. After being cleaned of most of the dust particles, the gases -- mixed with steam -- are discharged into the atmosphere.

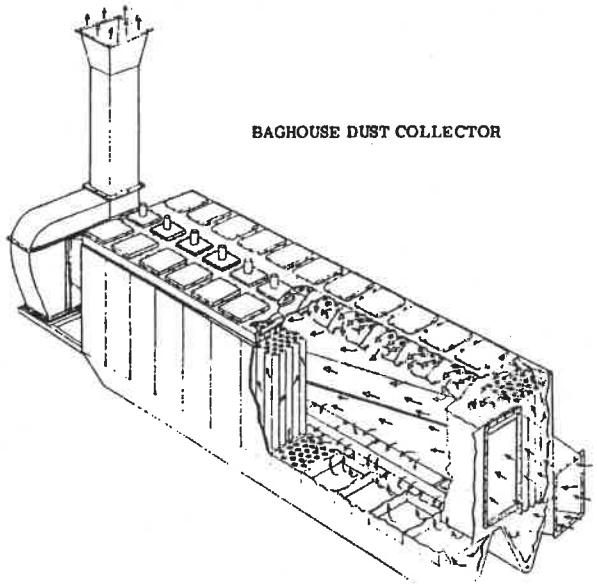
Because of the method of collecting the dust, wet collection systems are not capable of returning the dust to the aggregates.

Dry Collection Systems

Earlier we referred to bag house dust collectors as typical dry collection systems. The dust-filled hot gases are drawn from the dryer to the baghouse. Once in the baghouse, the gases are drawn through a series of cloth bags on which the dust is collected. This filtering process produces clean air (at the end of the unit) which is blown through the exhaust stack.

The dust-filled bags are automatically shaken every so many seconds to free the dust to fall into bins at the bottom of the unit. Mechanical screws in the bins carry the dust back to the foot of the hot elevator, where it may be carried to the hot bins. In this way, the dust may be utilized in the mix.

The dust may also be diverted from the hot elevator, to be wasted, if it is not needed, or stored in a silo for future use.



BAGHOUSE DUST COLLECTOR

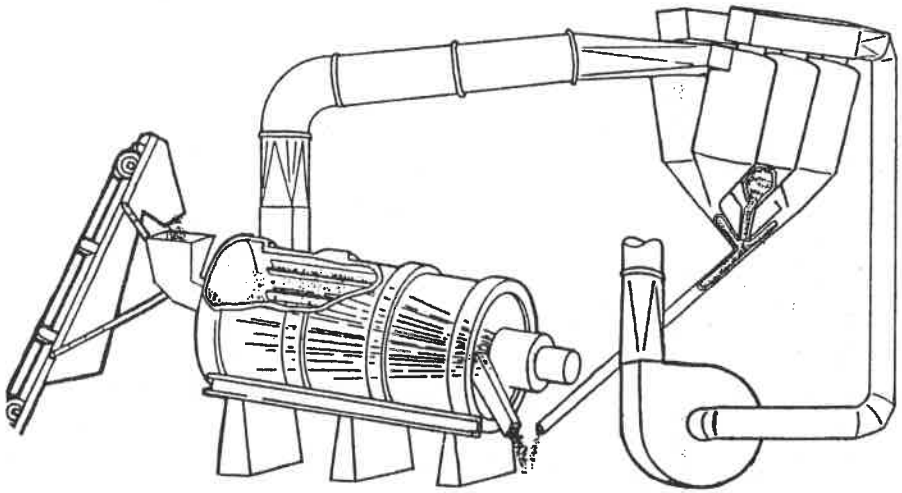
As a Qualified Technician, there are some things you should know about the dust-collecting process in bag house collection systems:

- If the aggregates going into the dryer are exceptionally moist, the fines will cake on the bags, which will reduce the efficiency of the dust collection process.
- If the combustion in the dryer is improper, oily films will accumulate on the bags, which also will affect the efficiency of the bags.
- If drying temperature is too high, damage to the bags may occur from overheating.

In general, check the discharge of the fines. They should be discharged at a uniform rate. If not, require the Contractor to make provisions for a uniform return of the dust.

Each hot mix plant may vary in the type and arrangement of equipment, but the operation is the same. Study the figure below. You should be able to follow the flow of material in the dryer and the dust collector.

This diagram shows a third type of dust collection -- the centrifugal method. This method can only be used in combination with either the wet washer or the bag house.



QUIZ

1. As the aggregates are drying, hot gases and dust are drawn from the dryer into the _____.

2. In a baghouse collector, the dust-laden gases are blown through _____ that collect the dust.

3. The exhaust fan blows the gases up through the _____.

4. How is the dust returned to the aggregates by the bag house collector? _____
_____

5. Is the dust returned to the aggregates before or after screening? _____

6. Can wet collection systems return the dust to the aggregates to be used in the mix? _____

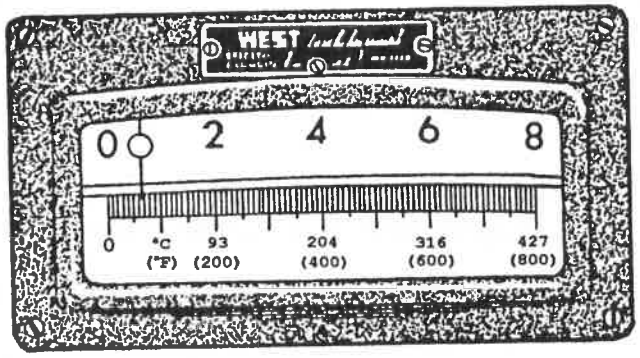
7. If the rate of dust discharge from the baghouse is not uniform, where should you look for possible causes?
_____
_____

See page 3-72 to check your answers.

INSPECTING THE DRYING-HEATING PROCESS

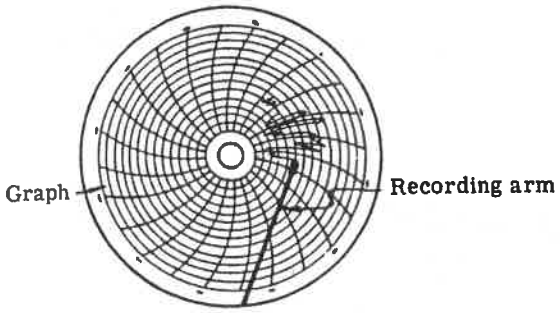
Aggregate Heating

A pyrometer or other instrument for automatically measuring the temperature of the hot aggregates must be located at the discharge chute of the dryer.



PYROMETER

Usually, the aggregates will be heated to a temperature between 275°F and 325°F at the time of mixing. The temperature will vary depending on characteristics of the asphalt plant. A pyrometer cannot be read as accurately as a dial thermometer because the graduations are usually at 10-degree intervals. The temperature of the heated aggregates will not be the same as the temperature of the mix due to temperature losses in the hot elevator, across the screens and in the hot storage bins. However, the temperature as shown by the pyrometer is a good indication of the final mix temperature.



RECORDING PYROMETER

Aggregate temperatures may be relayed from the sensing element to a recording pyrometer where they are recorded on a graph. The graph shows a continuous record of aggregate temperatures for each day's operation. The recording instrument is located in the plant operator's control house.

Aggregate Drying

Several hints will tell whether or not the aggregates are dry enough. Sweating occurs when moisture collects on the hot-bin walls. Usually this happens at the beginning of the day's operation, but can happen at any other time. It is a sign that the aggregates are not dry enough. Another hint of incomplete drying is excessive steam rising out of the hot mix. If there is an indication of too much moisture, there is a good chance that the problem is at the dryer or excessive moisture in stockpiles.

QUIZ

1. A pyrometer must continuously show the temperature of the aggregates leaving the _____.

2. Can a pyrometer be read as accurately as a dial thermometer? _____

3. Is the temperature of the heated aggregates -- as shown by the pyrometer --a good indication of the final mix temperature? _____

4. What are two hints that the aggregates are not dry enough?
_____ and
_____.

See page 3-72 to check your answers.

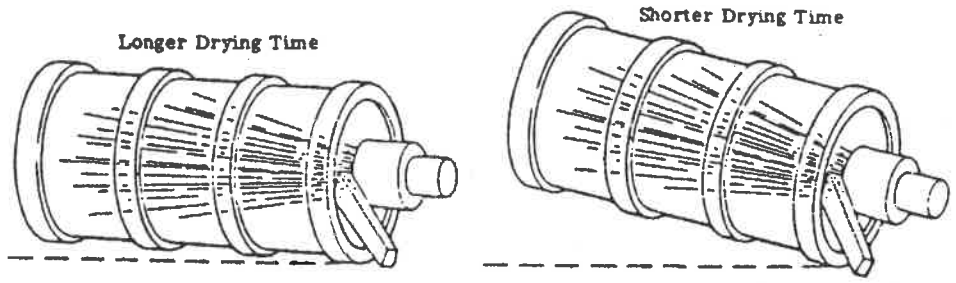
Heating-Drying Problems and Solutions

If the aggregates are not hot enough or dry enough, several things can be done:

- Reduce stockpile moisture -- There are several approaches to do this including: placing stockpiles on sloped paved surfaces, covering stockpiles, and careful control of technique in working stockpiles.

- Reduce cold feed -- For one thing, the quantity of aggregates entering the dryer can be reduced. This is an effective way to get hotter and dryer aggregates because more surface area is exposed to the heat.

- Increase drying time -- Another way to get hotter and dryer aggregates is to increase drying time. Drying time is controlled by the slope of the dryer. You may have noticed that the dryer is installed at a slope to aid the movement of aggregates through the dryer. If the slope is reduced, the aggregates will be held in the dryer for a longer period. Drying time also can be adjusted by removing or rearranging the lifting flights.



- Increase drying temperature -- A third way to get hotter and dryer aggregates is to increase the drying temperature. This involves turning up the burner and using more fuel. Care should be taken here as excessive fuel oil will not burn completely, leaving an oily coating on the aggregates. Black smoke from the exhaust stack is your first indication that fuel oil is not being burned completely. Incomplete burning, generally, is less serious if the burner uses natural gas instead of fuel oil. Excess mix temperature is also undesirable since this may damage the asphalt cement and may be too hot to be stable underneath rollers.

- Summary of the Solutions -- In any case, the drying rate, time and temperature depend on the sizes and moisture contents of the aggregates. Porous aggregates, for example, may require a longer drying time than non-porous aggregates. For better drying and heating, it is more effective to reduce the quantity of aggregates than to increase the drying temperature. The best solution is to minimize the moisture in the stockpiles prior to feeding to the plant.

QUIZ

1. Do porous aggregates generally require longer drying time than non-porous aggregates? _____

2. Do large quantities of aggregates dry faster than small quantities? _____

3. Drying time can be increased by reducing the _____ of the dryer.

4. Drying time also can be changed by rearranging the _____.

5. Does unburned fuel oil leave an oily film on the aggregates that would prevent the asphalt from coating properly? _____

6. Name three steps that can be taken to reduce moisture in the aggregate being fed to the cold feed.

   _____

   _____

   _____

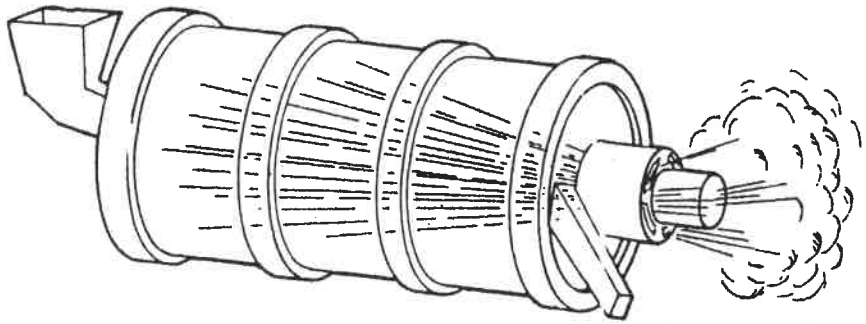
See page 3-73 to check your answers.

Fuel Combustion Problems and Solutions

Here are some additional pointers -- on the incomplete burning of fuel:

- Avoid frequent starts and stops -- Incomplete burning occurs most often when the plant is just starting up. This is one reason why frequent starts and stops in plant operations are to be avoided. A storage silo is very helpful in minimizing frequent starts and stops.

- Balance draft air with blower air -- Also, the burner may be adjusted so that air furnished by a blower atomizes the oil, reducing it to very small particles. For proper combustion or burning, the draft air should be in balance with the blower air. If draft air and blower air are not in balance, you may see a "puff back" at the burner end of the dryer.



"Puff back" indicates back pressure within the drum. It is caused by a lack of draft and can be corrected by increasing the draft air -- or by reducing the pressure of the blower air.

QUIZ

1. Does continuous operation of the plant result in a better product? _____

2. List three indicators of incomplete burning of fuel oil:

   _____

   _____

   _____

See page 3-73 to check your answers.

HEATING THE ASPHALT

Asphalt is heated in the storage tank before being pumped into the weigh bucket. Like aggregate temperature, asphalt temperature depends on characteristics of the asphalt. Most asphalts will be heated to between 250°F and 325°F . Some asphalts (PG 76-22, for example) may require more heating, but in no case should the temperature drop below 250°F at the time of mixing.

The mixing temperature of asphalt should be measured continuously with an armored thermometer installed in the feed line between the storage tank or in the storage tank itself.

The thermometer's sensing element should be installed where it always will be in the hot asphalt.

Asphalt temperatures should be uniform within the specified temperature range. If the thermometer indicates otherwise, several things should be checked.

The heating system may not be doing its job. Also, the storage tank, weigh bucket and asphalt lines may not be suitably insulated, or the thermometer may be faulty.

A rough check can be made on the accuracy of the thermometer by checking it against an accurate Department thermometer placed in the storage tank. However, be careful -- as the asphalt is extremely hot. Also, hazardous fumes should be avoided when the tank is first opened.

QUIZ

1. The desired asphalt temperature depends on characteristics of the _____.

2. Asphalt temperatures should never fall below _____ °F at the time of mixing.

3. The thermometer's sensing element always should be in the _____.

4. The asphalt thermometer may be located in the feed line between the _____ and the _____ _____ or it may be located in the _____ itself.

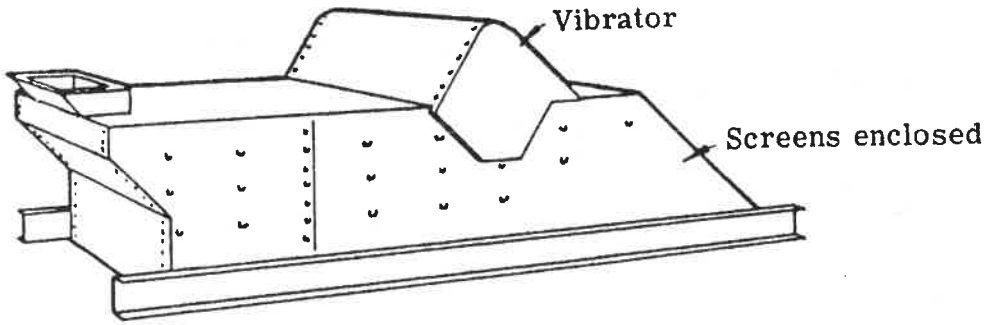
5. If the thermometer indicates improper asphalt temperature, you should check the _____, _____, and _____.

6. The accuracy of the thermometer in the asphalt line can be checked roughly by comparing the reading with the temperature in the _____ tank.

See page 3-73 to check your answers.

SCREENING AGGREGATES

At the beginning of this chapter, we mentioned that bad gradation tests tell you that something is wrong with the plant. Well, a common source of gradation problems is in the screening process. In this section, we will see how the screening process should work and what can go wrong.



SCREENING UNIT

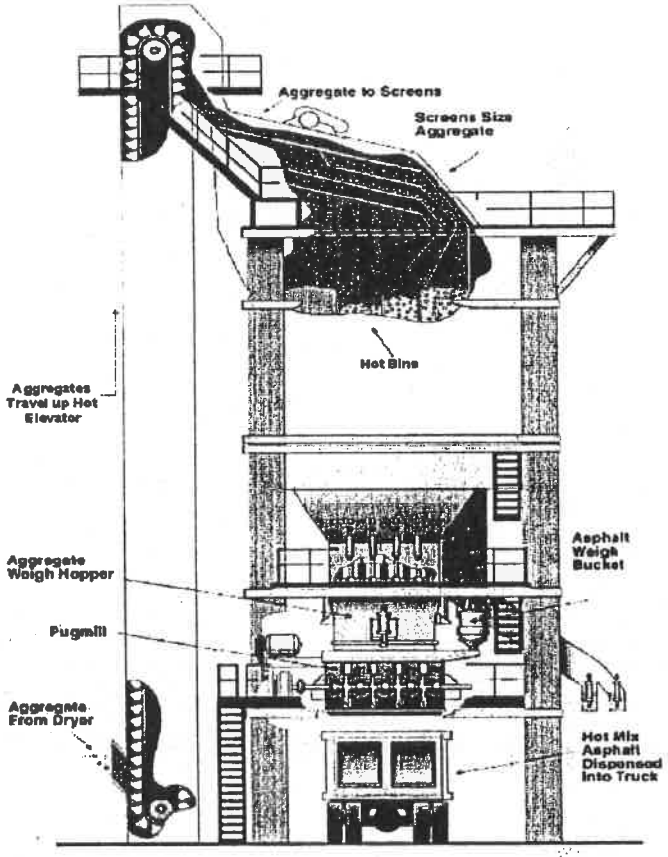
SCREENING PROCESS

A screening unit is shown above. It consists of various screens arranged in decks. A power unit vibrates the screening unit so that all the aggregates pass over or through the screens.

SCREEN CAPACITY

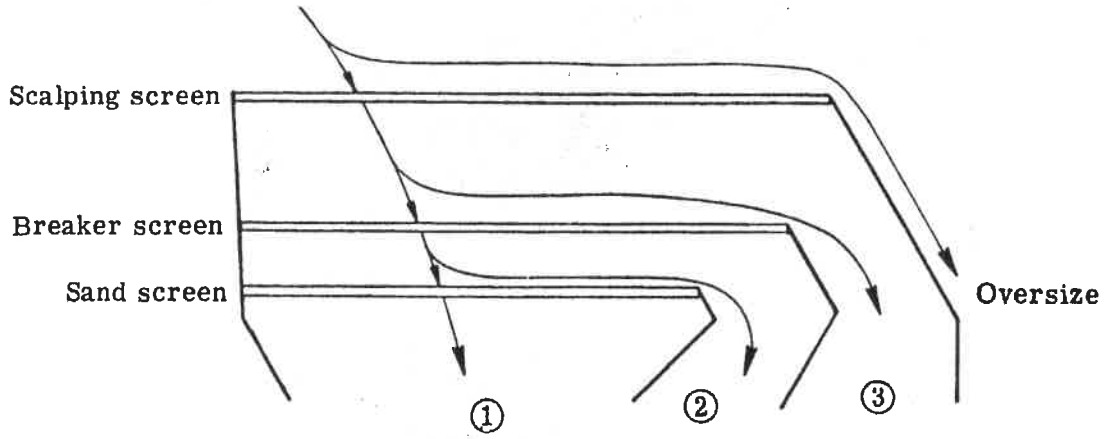
Generally, the screens will be able to handle more aggregates than the normal capacity of the plant, to prevent overloading the screens. Screen capacity should be greater than dryer capacity.

The screens are located at the top of the batch tower and are mounted over the hot storage bins. A typical batching tower is shown below.



SCREEN ARRANGEMENTS

The plant screens must be able to separate the aggregates into the specific sizes needed. To do this, a number of different screen arrangements can be used at hot mix plants. A three-deck arrangement is shown below:



The hot aggregates are discharged onto the scalping screen. Aggregates finer than this screen pass through to the next screen, the breaker screen, while everything larger is carried over and discharged. Aggregates larger than the breaker screen are carried into Bin Number 3, while the finer aggregates pass through to the sand screen -- where the aggregates are separated into Bin Number 1 or 2.

Two arrangements are shown below. Follow the flows of aggregates to get a general idea of how screening units operate:

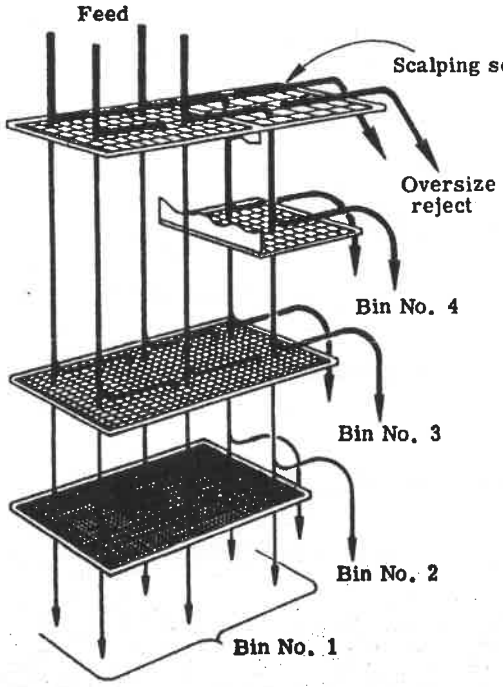


Figure 1

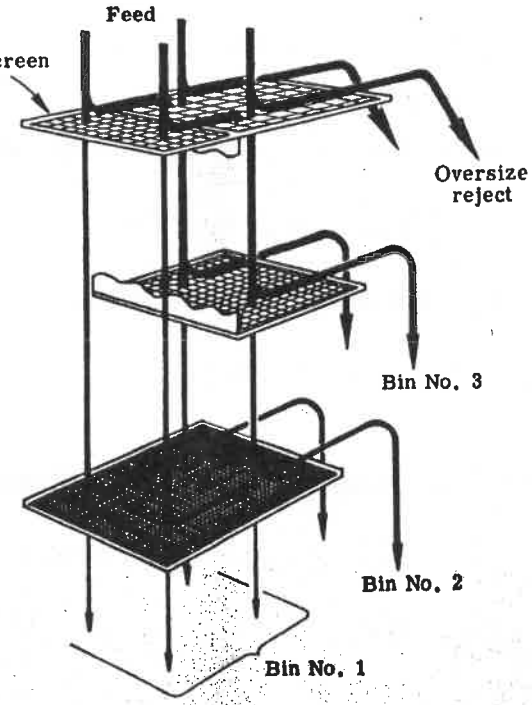


Figure 2

QUIZ

1. Oversize material that will not pass through the openings in the scalping screen is _____ _____.

2. Aggregates retained on the breaker screen go into Bin No. _____.

3. Aggregates passing the breaker screen fall to the _____ screen.

4. Aggregates passing the sand screen go into Bin No. _____, while retained material goes into Bin No. _____.

5. Bin No. 3 holds aggregates smaller than the _____ screen, but larger than the _____ screen.

6. In Figure 1, on the previous page, the aggregates are separated into _____ bin sizes.

7. The arrangement shown in Figure 2, on the previous page, separates the aggregates into _____ bin sizes.

8. Screen sizes and arrangements depend on the _____ _____ requirements of the mix.

9. As aggregates are emptied onto the top deck in Figure 1, some of the aggregates fall directly to the third deck. This prevents the second deck from becoming _____.

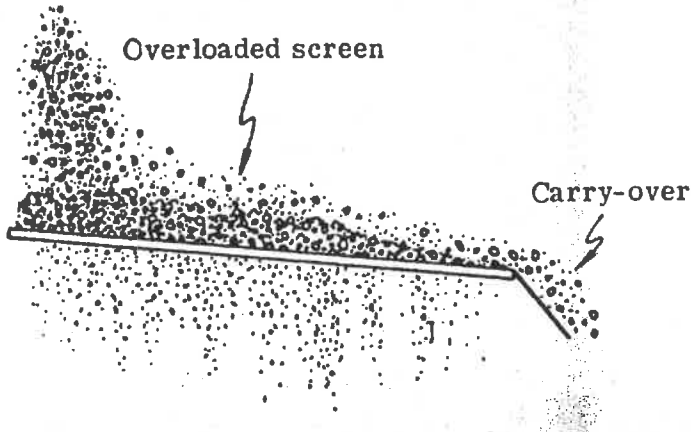
10. If aggregates are not screened effectively, will the hot bins be properly filled? _____

See page 3-73 to check your answers.

INSPECTING THE SCREENS

The screens should be inspected and cleaned regularly by the Contractor and at any time test results indicate gradation deficiencies.

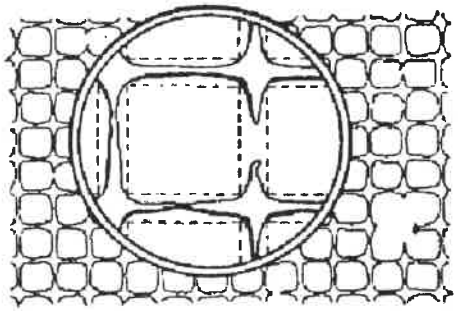
Overloaded screens cause the same trouble as clogged screens. In both cases the finer material is prevented from passing the finer screens and is carried on to be deposited in a bin that should contain only coarser material. This is called carry-over.



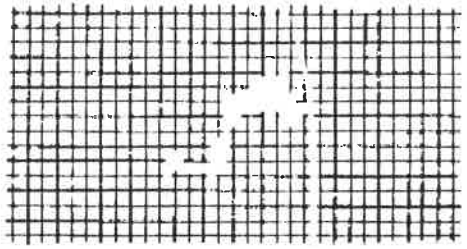
Some carry-over will be permitted to maintain the desired production rate. An increase in production may cause a jump in the carry-over, but carry-over will cause no trouble so long as the amount of carry-over is consistent and the gradation of the total mix remains within the designated limits. Any fluctuating or shifting in the amount of carry-over can affect gradation uniformity of the mix.

On the other hand, broken or worn screens cause coarse material to be deposited in a fine bin. Some coarse material is allowed in the fine bin. A maximum of 10% coarse material (plus ten) is permitted in the fine bin (minus-ten). More than 10% indicates that you should check the screens for wear and damage.

Typical screen wear is shown here:



A broken screen might look like this:



A break in a screen should be repaired, while worn screens will need replacing. Screens should be maintained in good condition. Proper gradation depends on it.

QUIZ

1. Should you inspect the screens whenever unusual amounts of improper aggregate sizes are found in the hot aggregate samples? _____

2. The depositing of finer material in a coarser aggregate bin is called _____.

3. Do clogged or overloaded screens cause carry-over? _____

4. Clogged screens should be _____.

5. Decreasing the cold feed reduces problems caused by _____ the screens.

6. Carry-over increases the proportion of _____ aggregates in the mix.

7. Do breaks or enlarged openings in the sieves allow oversized aggregates to pass? _____

8. What is the maximum amount of plus-ten material allowed in the fines bin? _____

9. Excessive amounts of aggregate sizes that should be deposited in Bin No. 2 are found in Bin No. 3. The screens should be checked for _____.

10. Excessive amounts of aggregate sizes that should be deposited in Bin No. 2 are found in Bin No. 1. The screens should be checked for _____.

11. Which of the following operations directly affect aggregate gradation in the finished mix?

    _____ Storing _____ Screening _____ Weighing _____ Mixing

See page 3-73 to check your answers.

STORING HOT AGGREGATES

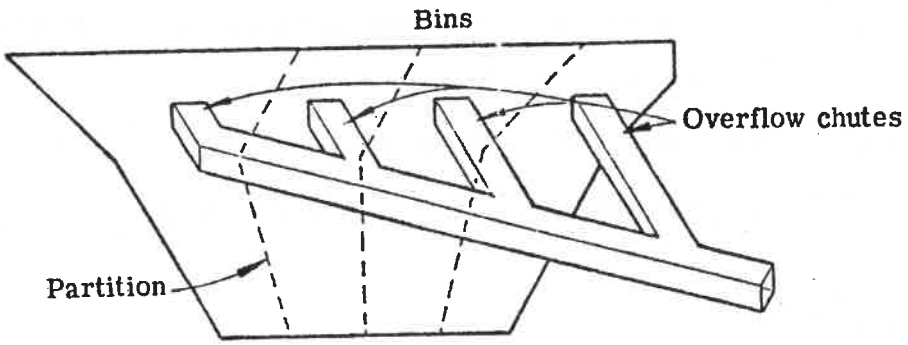
CONTROLLING GRADATION

Good hot mix depends on adequate storage for hot aggregates. Each hot bin should represent a certain aggregate size, as the weigh box accepts a specific weight of aggregates from each bin. The right combination of aggregate sizes is necessary for a good hot mix. A hot mix with gradation deficiencies is almost certain to result if the various aggregate sizes become intermixed between the hot bins.

Partitions between the bins should be high enough -- and free from holes -- to prevent the various aggregate sizes from mixing. The bins should not be overfilled. Overfilling can result in overflowing across the tops of the partitions.

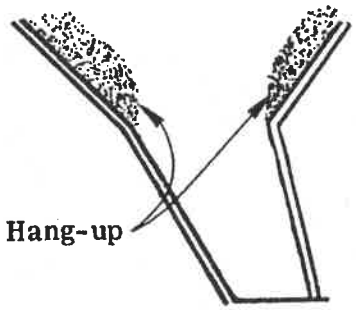
In cases of overfilling, the problem is prevented by overflow chutes. Each hot bin will have an overflow chute to prevent the aggregates from overflowing into another bin or filling to such an extent that the aggregates touch the vibrating screen.

Overflow chutes should be checked frequently to be sure that the aggregates can flow freely. If there is excessive discharge from the overflow chutes, the bins are being overfilled and the feed of aggregate into the plant is likely not balanced.

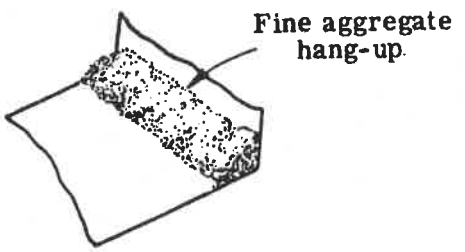


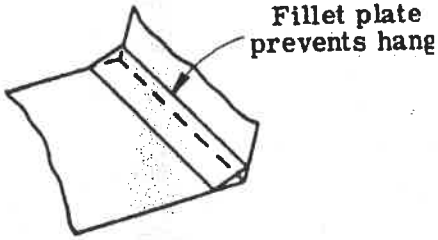
SUPPLYING AGGREGATES TO THE WEIGH BOX

Aggregate material that "hangs up" can interfere with the orderly transfer of aggregates to the weigh box. Fine aggregate material tends to hang up in the bin corners. Hang-up can cause too much aggregate material to be released at once when the level of aggregates gets low.



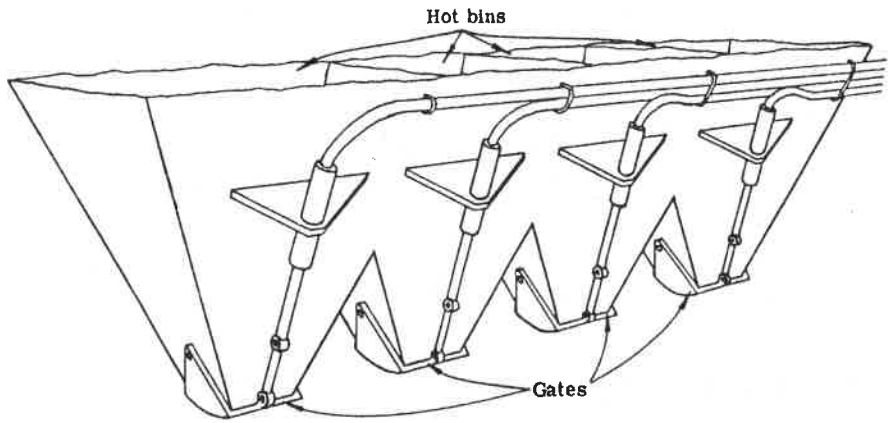
Hang-up can be helped by welding fillet plates in the bin corners. This eliminates the 90° angles.





The bins should not be allowed to run empty. They should be large enough to assure continuous operation of the plant.

The gates under the hot bins must be capable of opening and closing quickly. Typical gates are shown below:



The gates should close tightly to prevent leakage into the weigh box.

QUIZ

1. Getting rid of sharp corners can reduce _____.

2. The bin gates must close tightly and quickly to obtain the correct _____.

3. Your hot bin samples indicate improper gradation. List three things you might check for at the hot bins.
   _____
   _____
   _____

4. You're starting a new day at the plant. Aggregates have been left in the hot bins overnight. Unless the bins are emptied and recharged, the aggregates will be _____.

See page 3-73 to check your answers.

WEIGHING THE MATERIALS

Even if the hot mix is mixed and discharged according to plan, the hot mix will still be deficient if the materials are not weighed properly. Before being discharged into the pugmill, the materials for each batch should be weighed in the correct proportions.

Not enough asphalt can result in a "lean" hot mix with insufficient coating of the aggregate. Excessive asphalt gives a "soupy" mix. Such mix deficiencies can be avoided with proper inspection of the weighing operation.

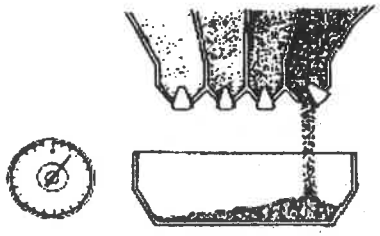
Aggregates are weighed on one scale, the asphalt is weighed on a separate scale.

WEIGHING AGGREGATES

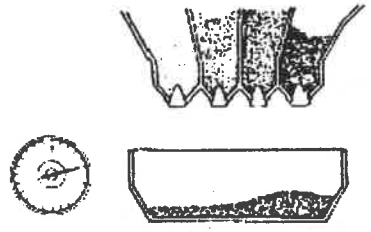
Aggregates are weighed in the weigh box or weigh hopper. A predetermined weight of each size aggregate is discharged from the bins into the weigh box. Where possible, weighing should begin with the coarse aggregates, followed by the next size aggregates and so on. Mineral filler (if added) also is discharged into the weigh box -- preferably between the first and second pulls -- until a certain weight is registered on the scale dial. The next page shows you what is involved.

The method used for weighing the various aggregate sizes is known as cumulative weighing. This means that the individual weights from each bin are accumulated or added together to obtain total weights.

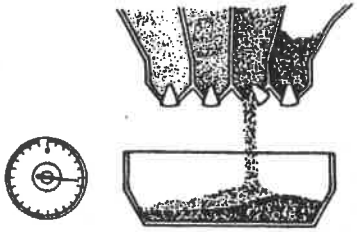
This is how aggregates and mineral filler are weighed in a batch plant:



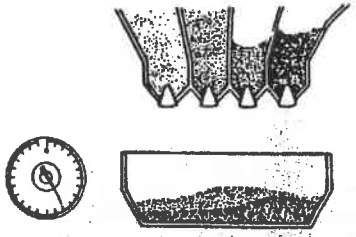
1. The discharge gate of an aggregate bin is opened, and the aggregates pour into the weigh box.



2. When the scale reading reaches a preset weight the discharge gate is closed.



3. The discharge gate of the next aggregate bin is then opened.



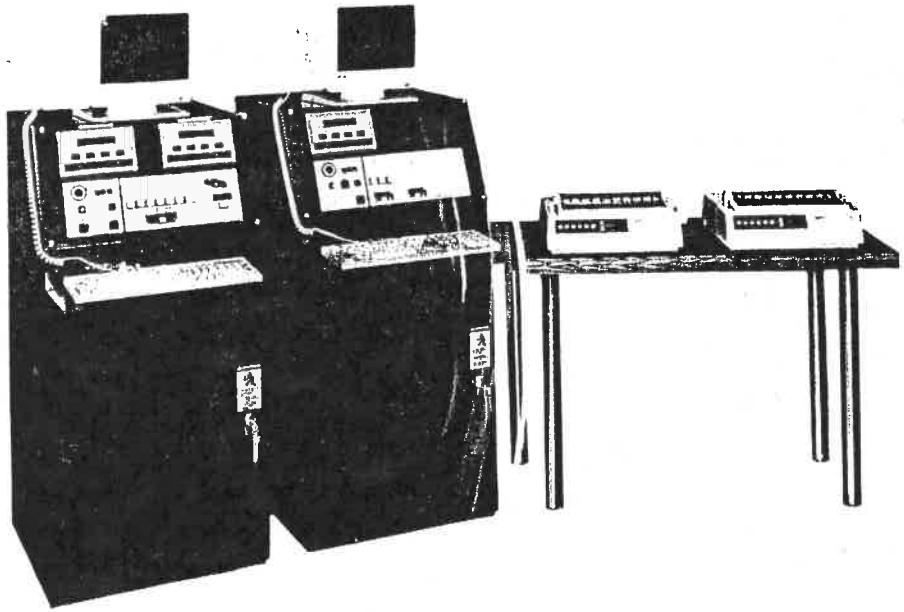
4. When the scale reaches a preset weight the discharge gate is closed.

CONTROL HOUSE

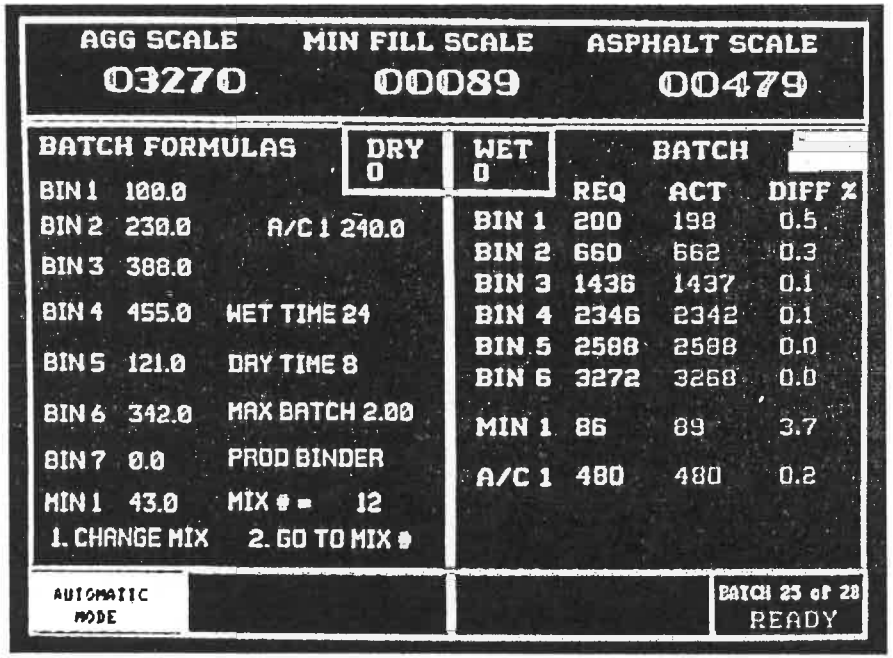
The weighing operations are controlled from the control house. The scale dials are located in or near the control house, which is positioned so that the operator can see the loads discharged. Most plants are operated automatically, although some are still manually operated.

Basically, manually operated plants are controlled by the operator pushing buttons, pulling levers, etc., to batch the materials. Automatically operated plants will run continuously on their own, after the controls are set to the desired batch amounts.

The illustration below shows a customized batch and silo loadout automation system.



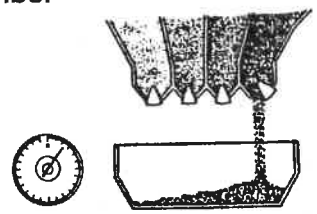
Modern computer automation can watch the quality of the batch while queuing up for the next batch; then print individual ingredient weights, the time, the date, the cycle times, notate the haul truck, notate the job, price the mix, calculate the tax, print instructions to the driver and accumulate the amount of mix on the project "today" and "to date" for the superintendent.



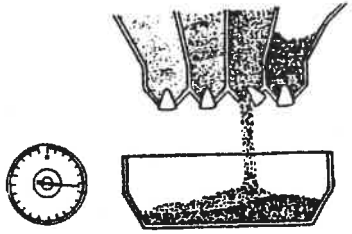
QUIZ

Suppose 1,000 lbs. of one size of aggregate are required and 1,500 lbs. of the next size.

1. The first size of aggregate is discharged into the weigh box until the scale reads _____ lbs.



2. The next size aggregate is added until the scale reads _____ lbs.



3. In a batch plant, is one batch mixed while the ingredients of the next batch are weighed out? _____

4. Is each aggregate size emptied into the pugmill individually? _____

5. Should the weigh box be large enough to hold all the dry ingredients for each batch? _____

See page 3-74 to check your answers.

The next few pages show how the aggregates are "pulled" from each bin until a predetermined weight is registered on the aggregate scale. As Plant Technician you need to know this -- and more. You must know how to determine the pull weights from each bin. Go on to the next page.

DETERMINING PERCENTAGES TO USE FROM HOT BINS

The Plant Technician must ensure that the hot aggregates are being proportioned by weight -- in such proportions that will result in a gradation that compares favorably with the Job Mix Formula.

The Mix Design gives the percentage of aggregates and asphalt needed in the mix. However, the percentage of each aggregate to be used from the hot bins is not shown on the Mix Design.

Let's discuss how we determine bin percentages.

The combined aggregates from the cold feed bins are dried and heated -- and then separated again by the plant gradation control unit into individual sizes. And the aggregate gradation in each hot bin may not be the same as the aggregate gradation in each cold bin.

For example, there might be four aggregate stockpiles that supply four cold bins. But after going through the plant gradation control unit, these four cold bins might be separated into three hot bins. Because the aggregates are now in bins according to a different gradation, the percentages shown on the Mix Design are of no use.

After going through the plant screening unit, these four cold feed bins would most likely be separated into three sizes. The aggregates passing the sand screen would be in Hot Bin Number 1. The aggregates coarser than the sand screen would be in Hot Bin Number 2. And the aggregates coarser than the breaker screen would be in Hot Bin Number 3. This is true if the screening unit does a perfect job of separating the aggregates, but there will likely be some small percent of coarser and finer material carried over into each bin. As long as this "carry over" is consistent it is permissible.

You cannot use the percentages shown on the Mix Design to determine what percentages to pull from the hot bins. What can you use? Well, a gradation sample must be run from each hot bin and then these gradations combined (by trial-and-error method) to find the percentage to use from each hot bin. The percentage used from each hot bin must result in a total gradation that compares favorably with the Mix Design.

Let's go through it, step by step:

1. Sample each hot bin.

2. Perform gradation tests on each hot bin sample. In our example, the following gradations were found:

Sieve Size	Percent Passing			Mix Design (JMF)
	Bin A	Bin B	Bin C	
½"	100	100	100	100
3/8"	100	100	100	100
No. 4	100	94	7	64
No. 8	97	8	5	42
No. 30	74	6	4	32
No. 50	52	3	3	23
No. 100	35	1	1	15
No. 200	10	1	1	5

3. The process of blending aggregates is a trial and error procedure. The basic formula for the blending process is:

   $p = Aa + Bb + Cc + ...$

   Where: p = the percentage of material passing a given sieve for the combined aggregates, A, B, & C .....

   A, B, C = the percentage of material passing a given sieve for each aggregate A, B, C .....

   a, b, c = proportions (decimal fractions) of aggregates A, B, C to be used in the blend $(a + b + c = 1.00)$

4. On paper, set-up a trial combination that will give you a mix that will correspond to the Mix Design. This is a tricky step -- one that requires some experience. It is suggested that the following steps be followed:

(a) Select the critical sieves for the aggregates in the blend.
(b) Determine an initial set of proportions a, b, c, etc., which will meet the specification requirements for the critical sieves.
(c) Check the calculated blend using the proportions determined for all sieves in the specification requirements.
(d) Adjust the proportions, as necessary to ensure that the percentages for all the sieves are within the specification limits.

To illustrate the process we will go through each of the steps listed above.

Step 4 (a) - Select critical sieves. The selection of the critical sieves is a judgement call. Different individuals will use different sieves. For this example we will establish that the No. 30 sieve will be used.

To establish a starting point for Bin A, divide the percent passing the No. 30 sieve (74%) by the mix design value (32%). This equals 43%. Then split the material between the other two sieves. The result is:

Bin No. A	43%
Bin No. B	28.5%
Bin No. C	28.5%

43% + 28.5% + 28.5% = 100%

Step 4 (b) Apply the trial percentages to the hot bin and gradations by multiplying each percentage by the trial percentage. The calculations are shown in the following table.

Trial No. 1

Sieve Size	Bin A	43 %	Bin B	28.5 %	Bin C	28.5 %	Composite	Design Mix
½"	100 x 0.43 = 43		100 x 0.285 = 28.5		100 x 0.285 = 28.5		100	100
3/8"	100 x 0.43 = 43		100 x 0.285 = 28.5		100 x 0.285 = 28.5		100	100
No. 4	100 x 0.43 = 43		94 x 0.285 = 26.8		7 x 0.285 = 2.0		71.8	64
No. 8	97 x 0.43 = 41.7		8 x 0.285 = 2.3		5 x 0.285 = 1.4		45.4	42
No. 30	74 x 0.43 = 31.8		6 x 0.285 = 1.7		4 x 0.285 = 1.1		34.6	32
No. 50	52 x 0.43 = 22.4		3 x 0.285 = 0.9		3 x 0.285 = 0.9		24.2	23
No. 100	35 x 0.43 = 15.1		1 x 0.285 = 0.3		1 x 0.285 = 0.3		15.7	15
No. 200	10 x 0.43 = 4.3		1 x 0.285 = 0.3		1 x 0.285 = 0.3		4.9	5

Step 4 (c) Check the calculated (composite) blend.

Step 4 (d) Adjust the proportions and continue the process until the desired results are obtained.

QUIZ

Use the data in the Hot Bin Gradation table and Job Mix Formula below to answer the following questions:

1. If the trial mix proportions were Bin No. 1 -- 50%, Bin No. 2 -- 20%, Bin No. 3 – 30%, how would the mix correspond to the mix design? _____

Use the work sheet format below to set up your trial combination.

Sieve Size	Bin No. 1	50 %	Bin No. 2	20%	Bin No. 3	30%	Composite	Job Mix
3/4"	100		100		100			100
½"	100		100		100			100
3/8"	100		100		85			96
No. 4	100		78		4.2			67
No. 8	92		2.3		1.6			47
No. 50	53		2.0		1.4			27
No. 100	23		1.8		1.4			12
No. 200	3.5		1.6		1.2			2.5

See page 3-74 to check your answers.

DETERMINING WEIGHTS TO PULL

Once the Quality Control Technician has determined the correct hot bin percentages, the technician must mark the aggregate scales.

The total weight of the batch is affected by the batch capacity of the plant. Let's say the total weight of the batch is 4,000 pounds – aggregates plus asphalt.

The Mix Design requires 6.0% asphalt, so 6.0 % of 4,000 lbs. = 240 lbs. of asphalt. This leaves 3,760 pounds of aggregate. So we just use our trial percentages to calculate the weight needed from each bin.

Bin No.	%		Weight from each bin
1	50	x 3,760 lbs. =	1,880
2	20	x 3,760 lbs. =	752
3	30	x 3,760 lbs. =	1,128
	100		3,760

In this case, the aggregate scale markers should be placed at:

1. 1,128 pounds [Bin 3],
2. 1,880 pounds [Bin 3 + Bin 2],
3. 3,760 pounds [Bin 3 + Bin 2 + Bin 1]

QUIZ

Use the following information for the questions below:

Bin No.	Trial%
#3 Coarse aggregates	34
#2 Medium coarse aggregates	30
#1 Fine aggregates	36

- Optimum asphalt content is 5.0%
- Batch size is 8,000 lbs.

1. What is the cumulative weight for Bin #2? _____ lbs.

2. What is the cumulative weight for Bin #3? _____ lbs.

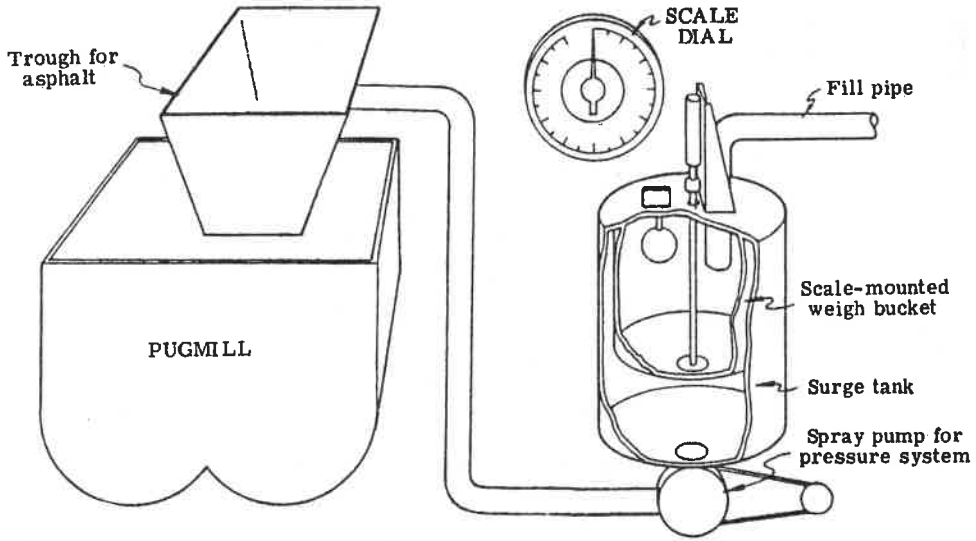
3. What is the individual weight for the A.C.? _____ lbs.

4. Does the Mix Design give the aggregate percentages for the hot bins? _____

See page 3-74 to check your answers.

WEIGHING ASPHALT

Asphalt is weighed separately in a scale-mounted weigh bucket.



In this system, when the asphalt reaches the predetermined weigh , a valve is closed (manually or automatically) to prevent more asphalt from being discharged into the bucket. Then, at the beginning of the wet-mixing period, another valve at the bottom of the bucket opens to allow the asphalt to be pumped into the trough above the pugmill -- or through a pressurized spray bar into the pugmill.

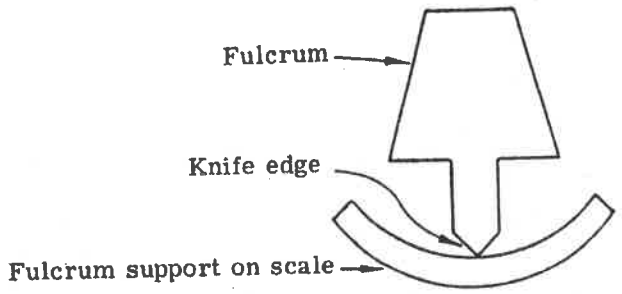
NOTE: In most modern plants, scale dials are located in the control house.

Asphalt scale dials usually are graduated at 1 lb. intervals. Aggregate scale dials usually are graduated at 5 lb. intervals.

The plant must be equipped with separate scales for aggregates and asphalt. The scales should conform to specifications and be adjusted or repaired as necessary before the plant is started up.

Scales used may be beam or springless-dial type scales.

Both the weigh box and the weigh bucket must be large enough to hold the materials required for a full batch. The weigh bucket capacity should be at least 10% in excess of the weight of the asphalt required in any batch.



The weigh box is suspended on scales and supported on a fulcrum. The knife edges should be constructed so that they are not easily thrown out of alignment. The alignment can be checked when you are checking the scale with weights. If you push the weigh box slightly, the dial indicator on the scale should return to the same weight.

The weigh bucket must be a non-tilting type. The bucket, as well as the flow lines and fittings, should be steam jacketed or otherwise insulated to prevent heat loss. The charging valve between the working tank and the weigh bucket should open and close quickly and should not leak.

QUIZ

1. The weigh box should hold enough dry materials for a _____.
2. Should the weigh bucket tilt to pour the asphalt? _____
3. If the asphalt is not hot enough, the weigh bucket and asphalt lines might not be properly _____.
4. Asphalt may enter the pugmill through pressurized _____ or through a _____.
5. Most asphalt scale dials are graduated at intervals of _____.
6. Should the scale dials be visible from the operator's position? _____
7. If indicated weights are not consistent, is it possible that the knife edges are in poor condition? _____

See page 3-74 to check your answers.

CHECKING SCALE ACCURACY

The aggregate scale and the asphalt scale must be checked for accuracy before the plant is started up. Also, during plant operation, you should make frequent checks to assure continued accuracy.

The scales may be either the beam type or the springless-dial type, but they must be sensitive to 0.5% of the maximum load that they will weigh. During production, weekly comparison checks shall be conducted in accordance with the procedures specified in the specifications to ensure the accuracy of the scales. You must be sure that the scales are certified every six months by a certified scale technician.

QUIZ

1. When must aggregate and asphalt scales be certified? _____

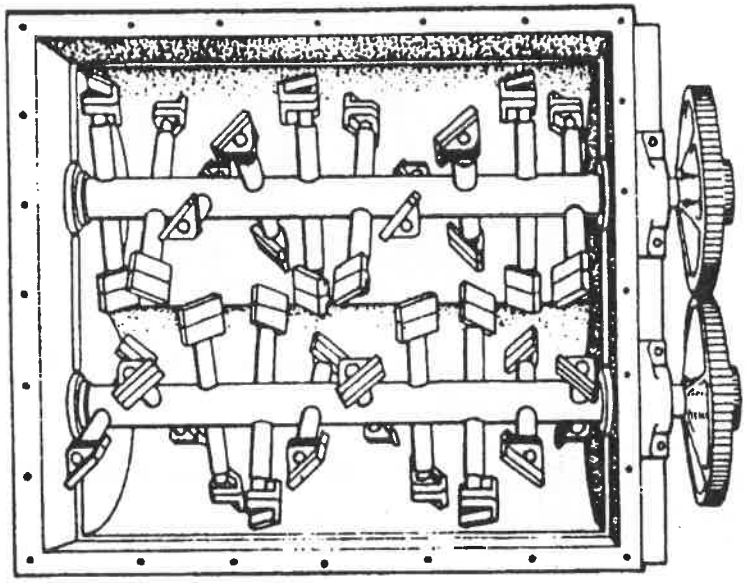
2. Who can certify plant scales? _____

See page 3-74 to check your answers. When you are ready, go on to MIXING.

MIXING

EQUIPMENT REQUIREMENTS

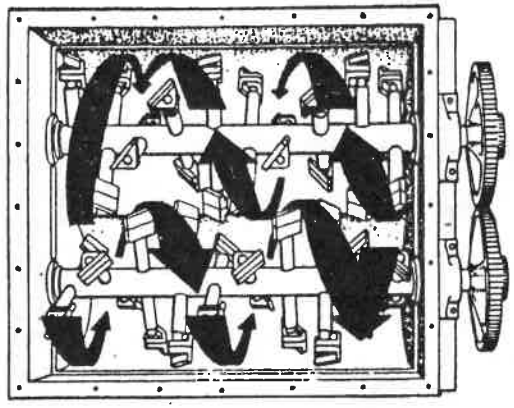
The mixing unit -- or pugmill -- must have twin shafts. The paddles are set to provide a uniform mix. Look at the shape and angles of the paddles in the figure below:



Worn paddles can cause improper mixing -- the aggregates will not be properly coated with asphalt. Paddles must be replaced or restored to their original dimensions when they become worn more than 3/4 inch.

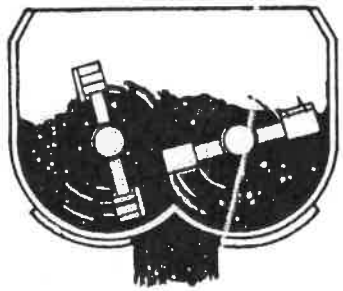
PUGMILL OPERATION

For better mixing, the paddles should lift the material upward in the center, then outward to both sides. This motion is shown below.



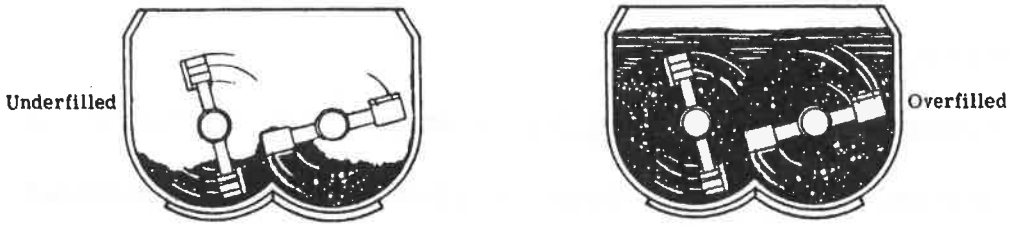
These paddles must be set to produce a circular, or "runaround," action in the pugmill. This is accomplished by reversing the paddle tips in the two opposite corners of the pugmill.

The discharge gate at the bottom of the pugmill should close tightly to prevent leakage during mixing. At the end of the mixing cycle, it opens to discharge the finished mix.

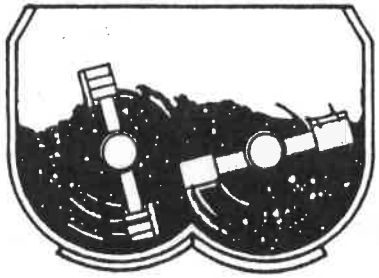


BATCH SIZES

Uniform coating of the aggregates with asphalt is not possible if the pugmill is either underfilled or overfilled.



The paddle tips should be exposed above the mix as they rotate.

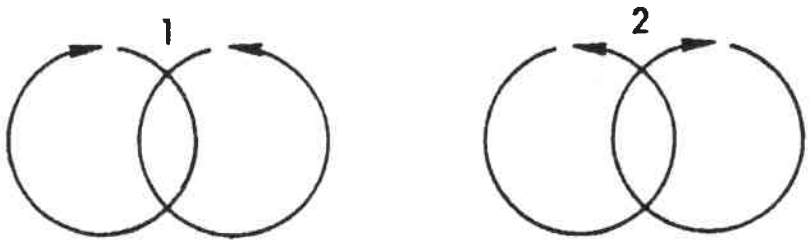


QUIZ

1. The pugmill has how many shafts? _____

2. Paddles should be replaced or restored to their original dimensions when they become worn more than _____.

3. Of the cycles pictured below, figure _____ shows the proper directions of shaft rotation.



4. Does the size of the batch affect thorough mixing? _____

5. The pugmill is filled properly if you can see only the tips of the _____ during the mixing process.

6. Which of the following can result in improper coating of the aggregates?

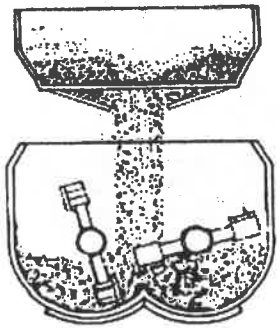
   1 ___ Overfilling 2 ___ Underfilling 3 ___ Worn paddles 4 ___ Leaking discharge gate

See page 3-74 to check your answers.

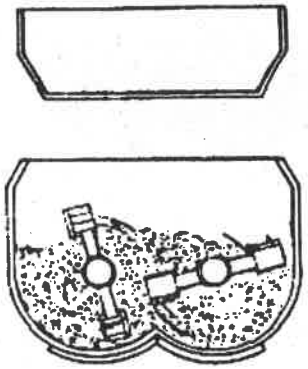
MIXING CYCLE

The mixing cycle is shown below and on the next page:

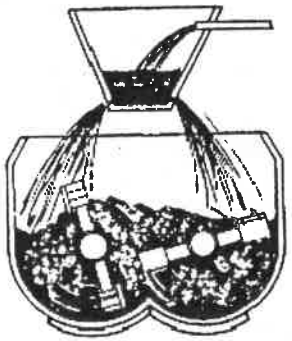
1. The gates of the weigh box are opened and the aggregates empty into the pugmill.



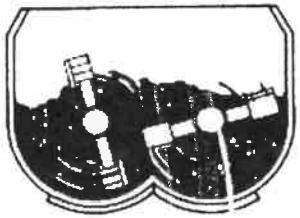
2. The dry ingredients are blended before the asphalt is added.



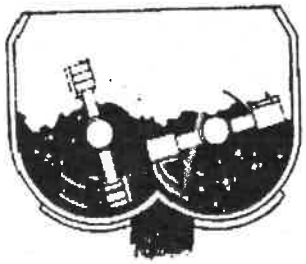
3. The asphalt is discharged into the pugmill through a trough or by a spray bar.



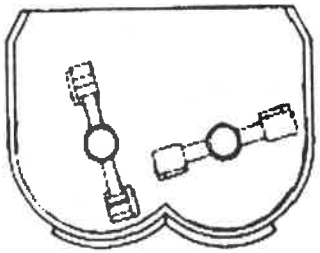
4. The aggregates and the asphalt are mixed.



5. The pugmill gate opens and the finished mix is discharged.



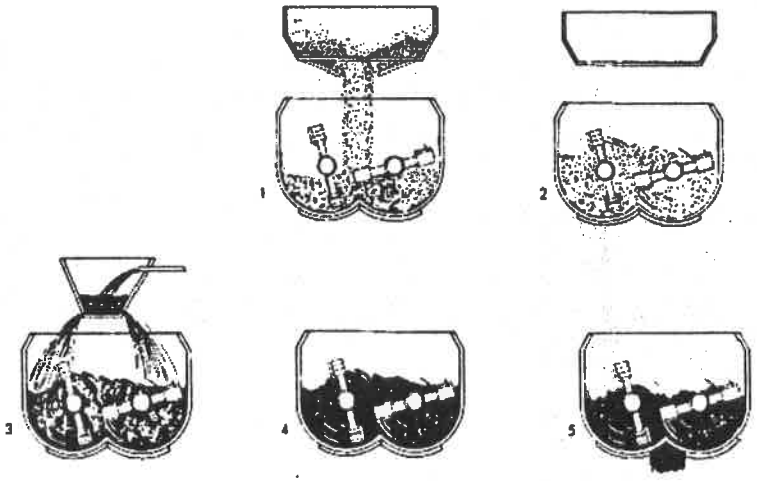
6. The pugmill gate closes to receive the next batch.



Batch plants must have automatic timing devices for mixing. The timing device controls the times of dry and wet mixing. But it should do more than that. It should lock the weigh box to prevent additional material from entering and it should lock the pugmill gate to prevent premature discharge. Also, it should lock the asphalt bucket throughout the dry-mixing period.

The timing device enables the whole mixing cycle to proceed automatically as soon as the weigh box gate is opened.

In this sequence of figures, Figures 1 and 2 represent the dry-mixing period and Figures 3 and 4 represent the wet-mixing period.



The mixing time cycle should be the minimum period needed to produce a uniform mix with well coated aggregates. A short mixing-time cycle is necessary to maintain a good production rate. It also prevents excessive wear on the paddle tip and excessive breakdown of the aggregate. Increased wet mixing time can increase the oxidation of the asphalt binder.

Actual mixing times are determined by the Contractor, within specified limits. The usual dry-mixing time is about 5 seconds and the wet-mixing time is a minimum of 35 seconds.

It is particularly important to watch the appearance of the mix if the mixing time is set at or close to the minimum allowed. If it looks like the aggregates are not completely coated with asphalt, you will need to have the mixing time increased.

The dry-mixing time can be checked with a stopwatch while watching the scales. The aggregate scale registers the total weight of aggregates in the weigh box. The asphalt scale shows the weight of asphalt that has been measured into the weigh bucket. Dry-mixing time is the interval between the aggregate scale indicator beginning to return toward zero and the asphalt scale indicator beginning to return toward zero.

To check the wet-mixing time, you have to be in a position to see both the asphalt scale dial and the pugmill gate. Wet-mixing time begins when the asphalt binder is first added to the pugmill. This is indicated by the asphalt beginning to drop from the actual asphalt weight. The wet-mixing period ends when the pugmill discharge gate opens.

In addition to checking the mixing cycle, you, as the Plant Technician, should see that the various mechanisms lock and release properly.

You may be able to see irregularities in the mix as it is discharged from the pugmill. If so, the problem can be traced to one or more operations preceding the discharge.

For example, if the mix is not blended properly, the problem may be in the mixing operation. Other problems may stem from improper batching or from other improper plant procedures or adjustments. The list below shows several of the irregularities that can occur in the mix.

- too much asphalt
- not enough asphalt
- too much coarse aggregate
- too-much fine aggregate
- improper coating of aggregates
- too hot
- too cold
- segregation

QUIZ

1. If hot mix can be discharged before the end of the wet-mixing period, the _____ device is faulty.

2. Should all plants have automatic timing devices? _____

3. Asphalt should enter the pugmill at the beginning of the _____ period.

4. Poorly coated aggregates could mean that the _____-mixing period is too short.

5. The beginning of the wet-mixing period is indicated when the asphalt scale begins to return to _____.

6. The wet-mixing period ends when the _____ opens.

7. The minimum allowable wet mixing time is set by the _____.

The answers to these questions start on page 3-74. How did you do on this quiz? Be sure you answer <u>all</u> questions correctly before continuing to TRANSPORTING THE HOT MIX.

TRANSPORTING THE HOT MIX

As a Plant Technician, you will have responsibilities in inspecting haul trucks and the loading operation.

CLEANING THE TRUCK BODIES

Trucks hauling mix to the roadway should have clean bodies. Dirty bodies contaminate the mix. No foreign materials should be in the truck bodies. So check them periodically to be sure they're clean. Be sure that fuel oil is not used as a cleanser -- except at the end of a work day and only when the truck body is well drained and washed out with a soapy solution.

Clumps of cold mix, water or other deleterious materials should be removed before the truck pulls under the pugmill or storage silo. It's a good idea to check all truck bodies early in each day's operation and at various times throughout the day. Be sure the truck operator removes all foreign matter that can contaminate the mix -before loading.

TARPAULINS

The truck bodies must have covers -- tarpaulins -- to protect the hot mix. Check the tarpaulins to be sure that they will cover the entire loads with lap on all sides. Also be sure that there are no holes in the tarpaulins.

LUBRICATING THE TRUCK BODIES

When a truck dumps hot mix at the roadway, some mix may stick in the body. This mix cools and hardens in the truck body. If the cold mix is dumped when the truck returns to the roadway with another load, the finished pavement suffers.

The contractor should treat the body with an asphalt release agent as often as needed to prevent sticking. Any material that can cause changes in the properties of the HMA or that can cause environmental problems should not be used. Do not allow excess lubricant to pond in the truck bodies. Diesel fuel should never be used as a release agent.

LOADING THE TRUCKS

Proper loading of the truck is important in preventing excessive heat loss and segregation. The mix should be discharged rapidly and the height of drop from the pugmill to the truck should be as short as possible. When loading trucks from a silo, it is important to drop the mix in batches and not to create cone shaped stockpiles by letting material continue to fall into the truck.

For this reason, the load should not be allowed to cone excessively. The preferred sequence of loading is to load the front first, back second, and middle last. This has been shown to minimize segregation.

QUIZ

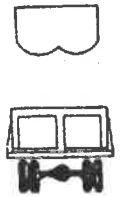
1. Which truck -- A or B -- has been properly loaded? _____

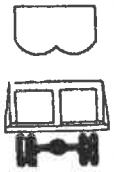
A 

B 

2. Of A and B, which load is less likely to be segregated? _____

3. Of C and D, less heat loss will occur in figure _____.

C 

D 

4. It's good practice to check for clean truck bodies:
   ____ A. at various times throughout the week.
   ____ B. at various times throughout the day.
   ____ C. every other day.

5. Is it the Plant Technician's responsibility to see that truck bodies are clean? _____

6. Should truck bodies be elevated and drained while waiting under the pugmill? _____

7. The truck body can be lubricated with _____ to prevent sticking.

See page 3-74 to check your answers.

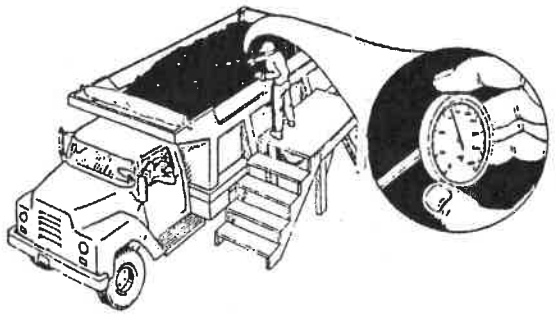
CHECKING TEMPERATURES OF HOT MIX

The temperature of the hot mix must be taken for each of the first five loads each day and for every fifth truckload thereafter. This check is made to ensure that the temperatures are within the limits established in the specifications. It is the responsibility of the Contractor's Quality Control Technician at the plant.

Temperature checks can be made two ways. The first method is to insert a thermometer through a hole in the side of the truck body. This is the simplest method.

Temperature checks can also be made by inserting dial thermometers into the hot mix. For convenience in making temperature checks, the Contractor will supply platforms which enable the Qualified Technician to check temperatures during or after loading.

Infrared thermometers have also been very successfully used to measure the surface temperatures in truck beds and on the roadway.



For an individual check, the mix temperature must be ±30°F of the temperature established on the mix design. The average of five checks must be within 15°F of the established temperature. The hot mix temperatures must be recorded on the delivery tickets.

QUIZ

1. The required temperature will be within the limits established in the _____.

2. How often must you check hot mix temperatures? _____
_____

3. The required hot mix temperature is set at 300°F. What is the allowable temperature range for a single load? _____ For an average of 5 loads? _____

4. After temperatures are checked, you must record them on the _____.

See page 3-75 to check your answers.

That's all for batch plants. Right now, go back and spot check yourself on some of the quizzes. If you need to, review now. If you are doing okay, go on to Chapter Four.

ANSWERS TO QUESTIONS

Page 3-4

A. Hot Storage Silos
B. RAP Feeder bins
C. Pollution Control System
D. Asphalt storage tanks
E. Cold feed bins
F. Cold feed Conveyor
G. Dryer
H. Truck loading ramp for pugmill
I. Control room
J. Hot Elevator
K. Truck loading ramp for storage silos
L. Weigh hopper
M. Conveyor to hot storage bins
N. Screen deck

Page 3-9

1. Sample divider (template)
   Sampling pan
   Platform scale
2. Plant foreman
3. Mix Design
4. 14.4%
   21.4%
   29.7%
   34.5%
5. Mix Design

Page 3-14

1. dryer
2. dry
3. drying
   heating
4. lifting flights
5. burner flame
6. No

Page 3-18

1. dust collector
2. cloth bags
3. exhaust stack
4. Bags are shaken; dust falls into bins; screws carry dust to hot elevator
5. Before
6 No
7. Moist fines caking on bags; oil film on bags; damaged bags caused by overheated fines

Page 3-20

1. dryer
2. No
3. Yes
4. Aggregate sweat in hot bins; excessive steam rises from hot mix.

Page 3-23

1. Yes
2. No, slower
3. slope
4. lifting flights
5. Yes
6. Place stockpiles on sloped surface; cover stockpiles; careful control of technique in working stockpiles

Page 3-25

1. Yes
2. Puff back
   Black exhaust
   Oily aggregates

Page 3-27

1. asphalt
2. 250
3. hot asphalt
4. storage tank; weight bucket; storage tank
5. heating system; insulation; thermometer accuracy
6. asphalt storage

Page 3-32

1. carried over and discharged
2. 3
3. sand
4. 1; 2
5. scalping; breaker
6. 4
7. 3
8. gradation
9. overloaded and clogged
10. No

Page 3-35

1. Yes
2. carry-over
3. Yes
4. cleaned
5. overloading
6. fine
7. Yes
8. 10%
9. clogging or overloading
10. breaks or wear
11. All of them

Page 3-39

1. hang-up
2. bin weights
3. Plugged overflow chutes
   Poor bin partitions
   Hang-up
4. cold

Page 3-44
1. 1,000
2. 2,500
3. Yes
4. No
5. Yes

Page 3-49
1. It is very close

Page 3-51
1. 4,864
2. 2,584
3. 400
4. No

Page 3-54
1. full batch
2. No
3. insulated
4. spray bars; trough
5. 1 lb.
6. Yes
7. Yes

Page 3-56
1. Every 6 months
2. Certified scale technician

Page 3-60
1. 2
2. 3/4 inch
3. 2
4. Yes
5. paddles
6. All of them

Page 3-66
1. automatic timing
2. Yes
3. wet-mixing
4. wet
5. zero
6. pugmill discharge gate
7. specifications

Page 3-69
1. B
2. B
3. D
4. B
5. Yes
6. No, before
7. approved release agents

Page 3-71

1. specifications
2. First five loads at the start of each day and every fifth load thereafter
3. 270°F to 330°F
   285°F to 315°F
4. delivery ticket

CHAPTER FOUR

Inspecting Drum-Mix Plants

CONTENTS

INSPECTING DRUM-MIX PLANTS

INSPECTION

This section reviews the inspecting of drum-mix plants in terms of their:

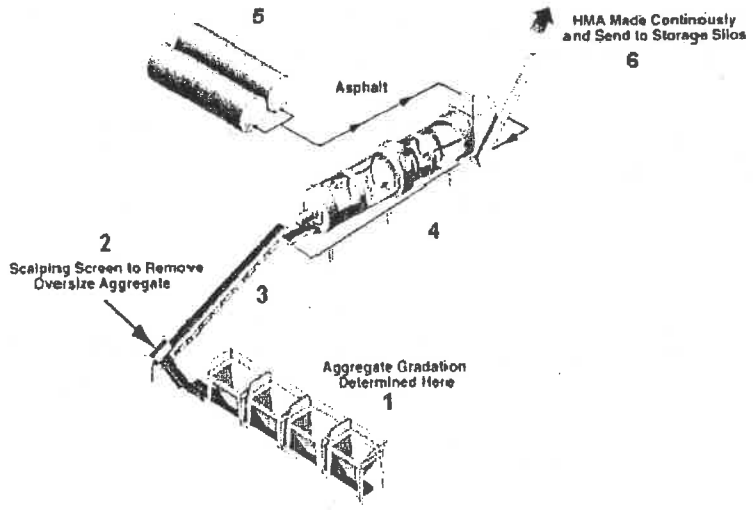
- cold aggregate supply,
- asphalt supply and feed,
- drying and mixing, and
- hot mix storage.

Remember that the key characteristics of the drum-mix plant that distinguish it from a batch plant are that the drum-mix plant:

- operates continuously rather than one batch at a time;
- combines the aggregate heating and drying function with the mixing function in the same drum; and
- has no gradation screens, aggregate hot bins, weigh box or weigh bucket, or pugmill as a separate mixer.

The flow of material (see next page) is straight forward. The individually sized and graded aggregates are loaded into each cold feed bin (1). The variable speed conveyors below each cold feed bin control the amount of each material to be added to the mix. The combined aggregates flow up a collecting conveyor and through a scalping screen (2) that is used to reject any oversize material. Materials pass along a charging conveyor (3) to the drum. The belt scale measures the combined material flow of the wet aggregates. The aggregates are dried in the dryer (4) and move to the cooler area of the drum. The control system measures the aggregate flow during the process. It calculates the dry material flow rate based on an assumption that the moisture has been removed from the aggregates. The moisture is deducted from the belt scale input based on the moisture content entered into the control system by the plant operator.

The control system then signals the asphalt pump to deliver the proper amount of asphalt from the asphalt tank (5) based on an input from the asphalt flow meter. As the aggregate increases or decreases, the asphalt flow increases or decreases to maintain the proper asphalt content in the mix.



After mixing, the mix is discharged onto a slat conveyor (6) or bucket elevator and sent to the storage silo or surge bin. The mix is then dispensed from the storage silo into a truck for dispatch to the job-site.

COLD AGGREGATE SUPPLY

The cold aggregate supply for a drum-mix plant is generally similar to that of a batch plant. Aggregates are stockpiled based on size and grade, transferred or fed to cold bins, and proportionally fed into the rest of the plant.

The key difference between a drum-mix plant and a batch plant is that the cold feed system in a drum-mix plant is the only means of measuring and controlling the aggregates. Since drum-mix plants do not re-separate and re-measure the aggregates later in the process, particular care is needed to ensure that:

- stockpiles are kept clean, well-graded, fully separated and free of excessive moisture;
- the cold bins are well separated and in good condition; and
- the proportioning of the aggregates is accurate.

Stockpiling

Inspecting the aggregate stockpiles is basically the same as for batch plants, but they **must be strictly controlled** – particularly in terms of any slight intermingling of gradations or contamination by foreign material that might be acceptable in the initial feed of a batch plant.

Cold Bins

The cold bins are generally the same as for batch plants, but they must be strictly controlled. Since an empty cold bin in a drum-mix plant would force all operations to stop, each bin should be equipped with a low-level indicator similar to those used on the hot bins in a batch plant.

Cold Feed Gates and Belts

The feed gates and belts are also similar to those in a batch plant in that they must:

- be adjustable,
- have a graduated indicator, and
- be lockable.

However, the cold feed system for a drum-mix plant has additional means of proportioning and controlling the flow of the aggregates.

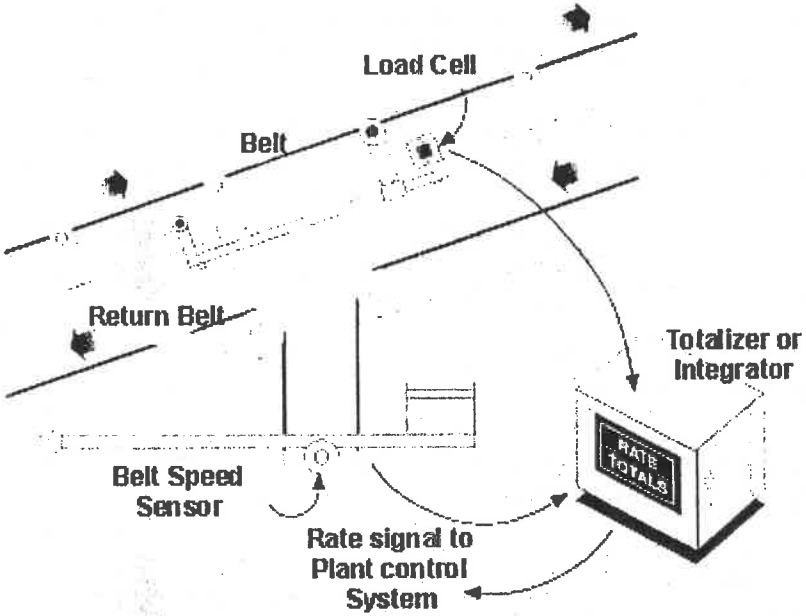
Even after production begins, the feed gates and belts should be checked each day to see that they are still:

- adjusted and locked at the proper setting, and
- operating properly with a uniform flow of material.

Weight-in-Motion Scale

The cold feed bins at a drum-mix plant are equipped with variable speed motors to drive the individual feed belts under the bins. These belt speeds are continuously shown on the master feed control in the operator's control station so that the operator can monitor and adjust the flow of material without stopping production and readjusting the individual bin gates.

The flow of the aggregates is also monitored and controlled by means of a weight-in-motion scale under the cold feed conveyor. It measures the weight of all the aggregates as they pass along the conveyor in tons per hour. On most drum-mix plants, the scale is linked to the asphalt cement flow so that a change in the aggregate flow will automatically adjust the asphalt cement rate proportionately. The aggregate weight at this point also includes moisture so the measured aggregate weight must be corrected for moisture before the rate of asphalt cement is determined.



The total tons per hour shown on the scale depends primarily on the capacity of the plant. This production rate and the mix design can be used to calibrate the cold feed system at the start of production. The calibration procedure is addressed later in the chapter.

ASPHALT SUPPLY AND FEED

The asphalt cement storage tank has the same basic requirements as the storage tank in a batch plant;

- a heating device,

- a means of monitoring the temperature, and
- insulation to maintain the heat.

The primary difference is the asphalt cement is pumped and measured continuously at a tons-per-hour or gallons-per-hour rate. As previously mentioned, most drum-mix plants have interlocking measurement systems that:

- provide a continuous reading of the quantity of asphalt being entered, and
- automatically adjust the asphalt flow as the total aggregate flow (corrected for moisture) is increased or decreased

DRYING AND MIXING

The key to the operations of a parallel flow drum-mix plant is the combination of the aggregate-drying and mixing functions in one drum.

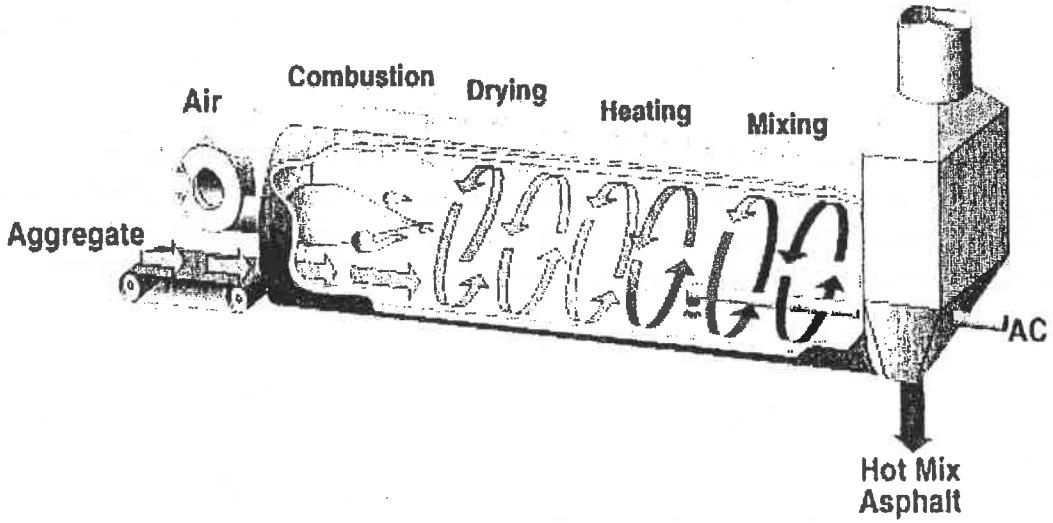
Aggregate Drying

The drying -- or "charging" -- end of the drum is very similar to the dryer in a batch plant. The aggregate is rotated around and distributed through the flame of a burner so that it is heated and dried. The key difference is that the burner is located at the same end at which the aggregates enter (Parallel-flow drum mix plant).

Mixing

There are three types of mixing plants. The parallel-flow drum mix plant, the counter-flow drum mix plant and the unitized dryer/mixer.

In the parallel-flow drum mix plant the mixing – or "discharge" – end of the parallel flow drum, the aggregates are sprayed with asphalt as they are rotated and distributed through the drum.



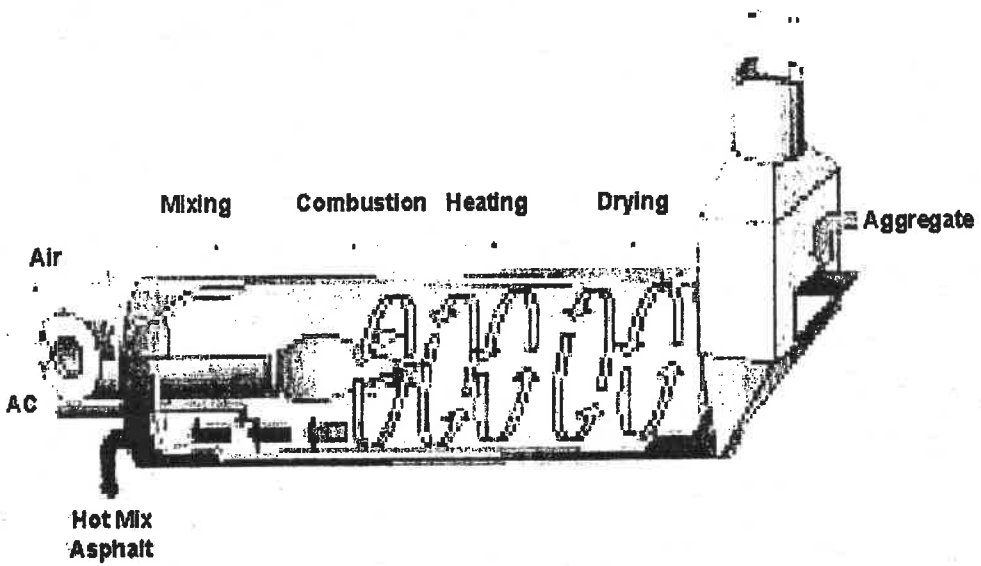
The asphalt binder is generally sprayed on to the aggregates about ten to twelve feet in from the hot mix discharge chute so that the aggregates will be fully mixed and coated by the time they leave the drum. The asphalt spray bar is adjustable to different distances into the drum.

However, one key consideration that must be given is where the asphalt is added in its relationship to the burner flame. It must be "shielded" from the flame so that it does not come in direct contact with the flame that could burn it. The "shielding" may be done in a variety of ways including:

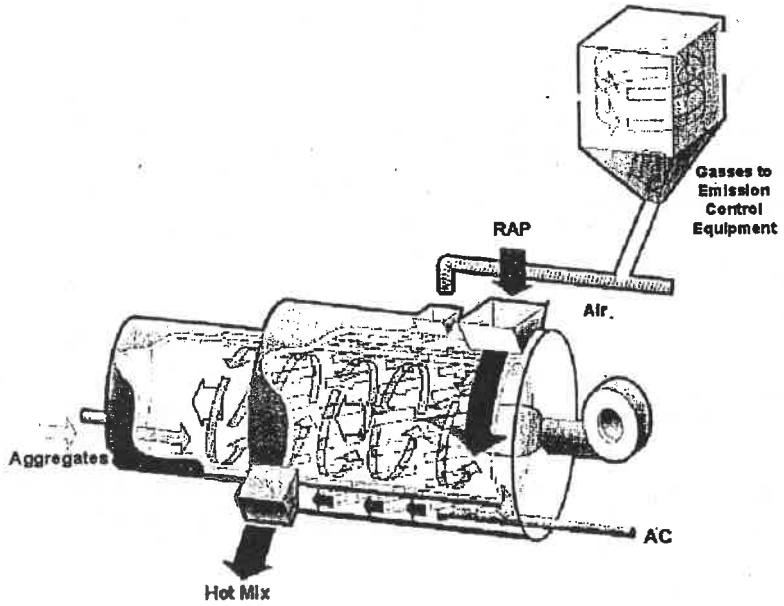
- arranging the flights in such a manner that a dense veil of aggregate is formed between the flame and the asphalt,
- positioning the burner further back, or
- providing a shielding device near the middle of the drum.

Although you cannot monitor the temperature of the uncoated aggregates in the drying end of the drum, you must closely monitor the temperature of the mix as it is discharged at the other end.

A counter-flow drum-mixer is very similar to a counter-flow dryer, but the burner flame is typically installed inside the dryer, and the mixing area is in the rear of the dryer, beyond the point where the gas stream starts in the dryer. The gas stream in a counter-flow drum-mixer starts at the burner head. Notice the drying, heating, and combustion areas in the counter-flow drum-mixer is similar to the drying, heating, and combustion areas in the counter-flow dryer.



The unitized dryer/mixer is another type of counter-flow drum-mixer. The drying, heating, and combustion areas of the unitized dryer/mixer are similar to the drying, heating, and combustion areas in the counter-flow dryer and the counter-flow drum-mixer, although the plant looks different. In this style of drum-mixer, the RAP, new liquid asphalt, and fines are introduced into the mixing area that surrounds the dryer....but the principles of drying are identical to those of a counter-flow dryer.



Drum-Mixer Adjustments

One of the key adjustments on a drum-mixer is the position of the asphalt spray. Typically, some experimentation is needed before production to position the asphalt spray so that it provides full coating of the aggregates without getting too close to the burner flame.

The total retention time (drying and mixing) in the drum-mixer can be adjusted by changing the angle of the drum. This is generally done as a pre-production adjustment since changes during production usually require re-positioning other elements of the plant. If adjustments are needed during production, it is usually more practical to adjust the burner flame or the flow rates of the aggregates and asphalt.

Counter-flow drum mix plants generally tend to separate the asphalt binder from the flame. RAP is also typically added in a compartment out of reach of the flame. Drum mix plants are much better suited for recycling than batch plants. However, either type of plant has been used successfully to produce recycled HMA.

RECYCLING WITH A DRUM-MIXER PLANT

Reclaimed Asphalt Pavement (RAP) is introduced into a parallel flow drum-mixer plant through the recycle collar. The RAP is heated convectively with the hot gases like the virgin aggregate. The RAP is introduced further down the drum in the cooler part of the drum, so that the asphalt in the RAP is less likely to overheat and cause smoking.

The temperature at the RAP introduction area can vary depending on the length of the drier; the gas flow velocity; the heat transfer efficiency; the percentage, gradation, and moisture content of the RAP; and the size, moisture content and percentage of virgin aggregates.

There are many configurations of drum-mixers that are used for the processing of RAP material. A further discussion of the various types is included in the Asphalt Plant Level II course being taught as a part of the FDOT Construction Training and Qualification Program (CTQP).

QUIZ

1. In the cold aggregate supply system for a drum mix plant, particular care is needed in controlling...(Circle one or more)

   A. the stockpiles.
   B. the cold bins.
   C. the proportioning of the aggregates.
   D. All of the above

2. Which of the following aspects of hot bins in a batch plant would also apply to the cold bins of a drum-mix plant? (Circle one or more)

   A. They tend to "sweat" at the start of each day's production.
   B. They have low-level indicators to warn against emptying.
   C. They open and close separately to measure out each gradation in turn.
   D. None of the above

3. On most drum-mix plants, if the rate of aggregate flow is increased, the asphalt rate will...(Circle one)

   A. remain the same.
   B. be automatically decreased.
   C. be automatically increased.
   D. be manually increased or decreased depending on the temperature of the mix.

4. The two-primary considerations in determining where the asphalt spray is positioned in a parallel flow drum are:

   A _____, and
   B _____

5. Which of the following drum-mixer adjustments would be more practical after production has started? (Circle one or more)

A. Adjusting the burner flame
B. Changing the angle of the drum
C. Adjusting the aggregate and asphalt flow rates
D. Any of the above

Check your answers on page 4-25.

AGGREGATE CALIBRATION

This section discusses the procedure for calibrating the aggregate metering system of a drum-mix plant. The metering system consists of the cold feed gates and belts and the weight-in-motion scale, mentioned earlier in the chapter.

Calibration is needed both to check the accuracy of the weight-in-motion scale and to determine the weight of the aggregate fed from each cold bin. Because the individual bin feeders are not equipped with scales, a graph must be made of the tons of aggregate fed versus the feeder belt speeds for each bin. The graph then is used to adjust the feeder belt speeds for different production rates.

The procedures in this section are acceptable and widely used, although other procedures may be used. In practice, the Qualified Plant Technician should check the recommendations of the manufacturer of the plant before calibrating the aggregate metering system.

SAMPLING DEVICE

A drum-mix plant is required to be equipped with a sampling device to assist in the calibration procedure. The sampling device permits the diversion of aggregate from the cold feed conveyor to a truck or other suitable container, so that an accurate weight of a sample can be determined.

OVERALL PROCEDURE

This section discusses one acceptable procedure for calibrating the aggregate metering system. It is a general procedure -- specifics are addressed in the sections that follow this one.

1. Set the cold bin gates at openings that allow continuous feed of the materials. The maximum size of the materials and the approximate percentage to be used are the primary considerations in the selection of the gate openings.

2. Start the main conveyor.

3. Start the variable speed belt feeder from the coarse aggregate bin. (Set the moisture compensator to zero.) Increase the speed until the weight-in-motion scale reads about 50 percent of the desired production rate. (Be sure to use the sampling device to divert the material).

4. Record the speed of the feeder belt and the reading of the weight-in-motion scale.

5. Stop the belts and remove the material from a six-foot section of the main conveyor belt. Weigh the material removed from the belt and record the weight.

6. Repeat Steps 2 through 5 and average the sample weights. Convert the average to tons per hour and compare the figure with the readings from the weight-in-motion scale.

7. Adjust the weight-in-motion scale, if needed, so that it reads out the measured weights. Test the adjustments made by repeating Steps 2 through 6.

8. After the weight-in-motion scale is calibrated, the scale's digital read-out is used to make a graph of the aggregate weights delivered versus the feeder belt speeds for each bin. At a minimum, the graph for each bin should be based on four belt speeds. (During this procedure, the moisture compensator is set for the appropriate amount of moisture in each aggregate so that the weights determined are on a dry basis.)

9. Prior to the start of production each day, the main conveyor belt is started with the diversion chute in place. The speed of the belt for each cold bin is increased until the belt speed read-out indicates that the proper weight is being fed and the weight-in-motion scale indicates that the accumulated weights equal the desired production rate.

10. The conveyor belts are stopped and a composite sample is obtained from the main conveyor belt. A wash gradation is run on the sample. If the gradation results do not compare favorably with the job mix formula, adjustments are made in the quantities of materials pulled from the cold bins.

QUIZ

1. The aggregate metering system consists of the _____ and the _____ _____.

2. The calibration procedure checks the accuracy of the _____.

3. The cold feeder belts are calibrated to produce a graph of the _____and the _____ _____.

4. The Plant Technician should check the _____ before starting to calibrate the aggregate metering system.

Check your answers on page 4-25.

WEIGHT-IN-MOTION SCALE

This section presents an example of the calculations for the weight-in-motion scale calibration (Steps 2 through 7 in the overall procedure).

The main conveyor is running at a speed of 225 feet per minute. The gate opening on a coarse aggregate cold feed bin (Bin No. 1) is set at 4 inches. The variable speed belt feeder for Bin No. 1 is increased until the weight-in-motion scale reads 90 tons per hour, about half of the desired production rate. (The moisture compensator is set to zero during weight-in-motion scale calibration.)

The speed of the belt feeder for Bin No. 1 is recorded. The belt feeder and the main conveyor are stopped. Material is removed from a six-foot section of the main conveyor and is found to weight 76 pounds. The main conveyor is started again and the speed of the belt feeder is increased until the weight-in-motion scale reads 90 tons per hour. The belts are stopped again and another six-foot section of material from the main conveyor is removed and weighed. The weight is 78 pounds.

The two weights are averaged: (76+78) / 2 = 77 pounds

The following formula is used to determine the weight of the aggregate in pounds per minute:

$$q = \frac{WR}{r} = \frac{77 * 225}{6} = 2{,}887.5 \ lbs./\text{min.}$$

Where:
- q = rate of aggregate, lbs./min.
- W = measured weight of aggregate, lbs.
- R = speed of the belt, ft./min.
- r = length of the belt from which the material was removed, ft.

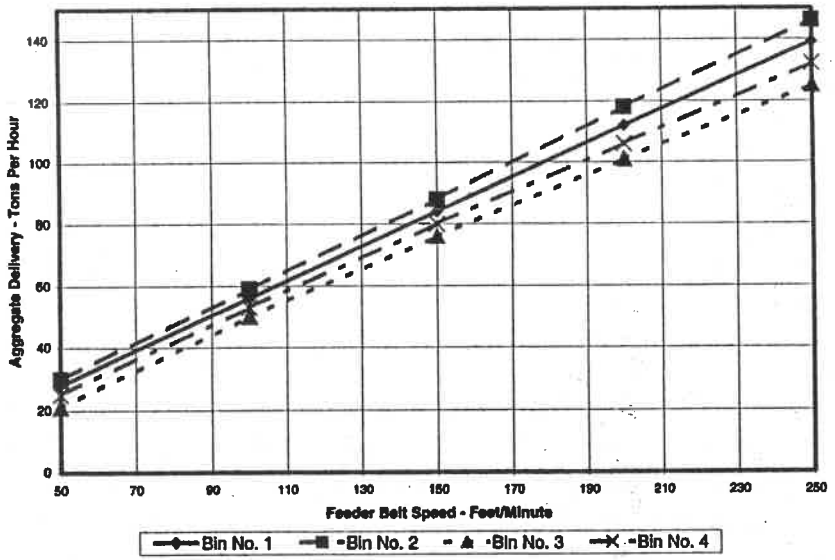
The pounds per minute figure is converted to tons per hour:

$$q = \frac{2{,}887.5 * 60 \ \text{min}/hr}{2{,}000 \ lbs/ton} = 86.63 \ tons/hour$$

Finally, adjustments are made to the electronics of the weight-in-motion scale to compensate for the difference between the 86.63 tons per hour measured and the 90 tons per hour shown on the scale's digital read-out.

BELT FEEDER

After the weight-in-motion scale is calibrated, the scale's read-out can be used to develop a table of the aggregate delivered in tons per hour and the belt speed in feet per minute. Then the table is graphed (Step 8 in the overall procedure above).



Let's take a sample problem and follow through the development of a calibration chart and the determination of the belt feeder speeds for the cold feed bins.

The mix type is SP-I2.5. The approved mix design shows the percentages of the aggregates to be used as follows:

Cr Stone Coarse	Cr Stone Intermediate	Cr Stone Screenings	Local Sand
20%	30%	25%	25%

And the bins are set up as follows:

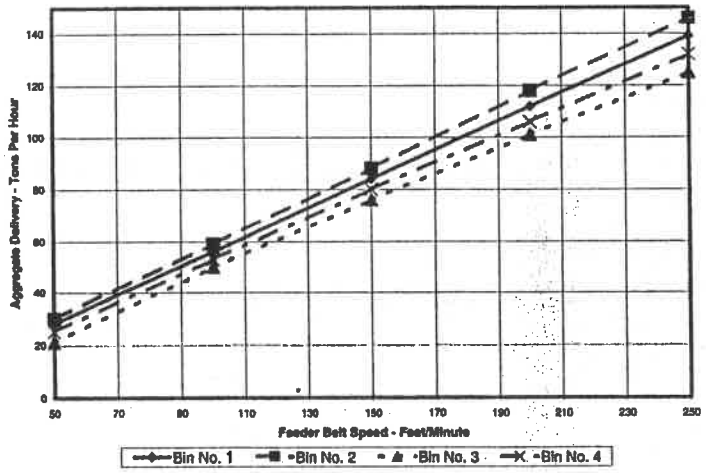
Bin #1: Crushed stone, coarse
Bin #2: Crushed stone, intermediate
Bin #3: Crushed stone, screenings
Bin #4: Local sand

All belts are to be calibrated at feeder belt speeds of from 50 to 400 feet per minute in 50 feet per minute intervals. The feeder belt for each bin is run at the various speeds (50 FPM, 100 FPM, and so forth), and belt samples are taken and weighed. (Remember that the moisture compensator should be set for the appropriate amount of moisture in each aggregate so that the weights determined are on a dry basis.)

The sample weights are converted to tons per hour figures (using the same formulas as in the calibration of the weight-in-motion scale). The resulting calibration chart is shown on the next page.

Belt Feeder Speed (FPM)	Bin #1 Coarse (TPH)	Bin #2 Int (TPH)	Bin #3 Scrngs (TPH)	Bin #4 Sand (TPH)
50	28	30	21	25
100	56	59	50	53
150	84	88	76	80
200	112	118	101	106
250	139	146	125	132
300	167	175	151	159
350	195	205	176	185
400	223	234	202	212

The figures from the calibration chart then are plotted as a graph. The graph for our example is plotted through 250 FPM -- the range that we are working with. (For FC-5, the graph should be extended to 400 FPM.)



Let's select a plant production of 200 tons per hour. The aggregate proportions for the mix are, again, as follows:

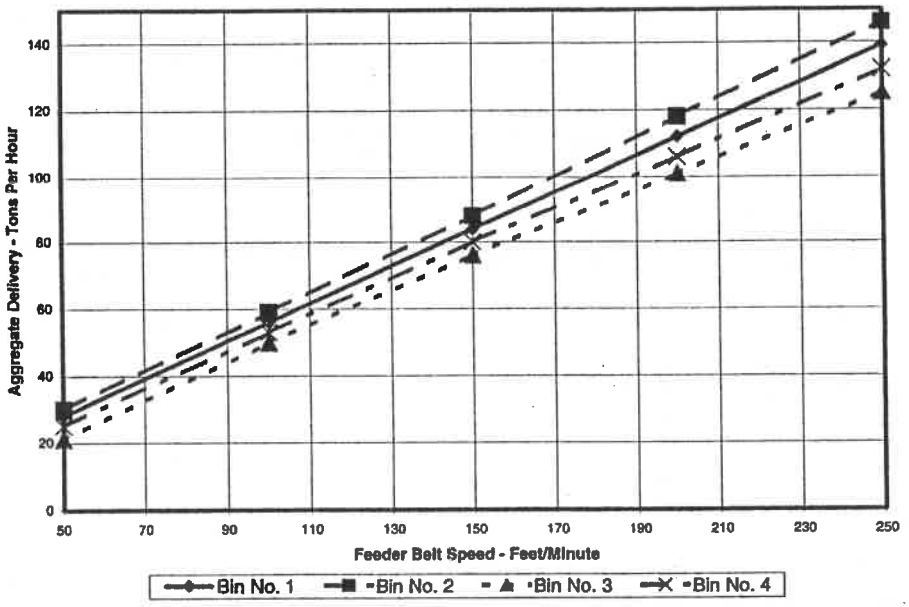
Crushed stone, coarse:	20% Bin No. 1
Crushed stone, intermediate:	30% Bin No. 2
Crushed stone, screenings:	25% Bin No. 3
Local sand:	25% Bin No. 4

The design mix shows the optimum asphalt content as 6.0%. Thus, we must correct the bin percentages to relate to the total mix. The total aggregate in the mix is 100% - 6% = 94%, so the bin percentages are corrected as below:

Bin No. 1:	20% x 0.94 = 18.8%
Bin No. 2:	30% x 0.94 = 28.2%
Bin No. 3:	25% x 0.94 = 23.5%
Bin No. 4:	25% x 0.94 = 23.5%

We selected a production rate of 200 TPH; the quantity of aggregate to be fed from each bin is calculated as follows:

Bin No. 1:	18.8% x 200 TPH = 37.6 TPH
Bin No. 2:	28.2% x 200 TPH = 56.4 TPH
Bin No. 3:	23.5% x 200 TPH = 47.0 TPH
Bin No. 4:	23.5% x 200 TPH = 47.0 TPH



Then, we can pick off the belt speeds from the graph of the calibration table. They are:

Bin No. 1: 68 FPM
Bin No. 2: 95 FPM
Bin No. 3: 97.5 FPM
Bin No. 4: 90 FPM

ASPHALT CALCULATION

The gallons of asphalt per hour can be calculated for setting the asphalt metering system of the plant. The following equation is used:

$$AR = \frac{P}{100} \times T \times \frac{2{,}000}{W} \times \frac{1}{60}$$

Where:

AR = asphalt rate, gal./min.
P = optimum asphalt in mix, percent
T = production rate, tons per hour
W = the temperature-corrected density of the asphalt, lbs./gal. (typically about 8.4 lbs/gallon)

Suppose the optimum asphalt content is 6% and the production rate is 200 TPH. These values are substituted in the formula as below.

$$AR = \frac{6}{100} \times 200 \times \frac{2{,}000}{8.4} \times \frac{1}{60} = 47.71 \ gpm$$

ASPHALT CALIBRATION

For a drum mixer, the amount of asphalt cement is calibrated by pumping the material into an empty container, the tare weight of which is known. Most often, an asphalt distributor truck is used for this purpose. The actual weight of the material delivered to the container is determined. The weight of the material indicated by the metering system as having been delivered is then determined by multiplying the corrected volume delivered from the meter totalizer by the specific gravity of the asphalt cement. With some systems, this calculation is done automatically. The actual weight is compared with that calculated by the metering system. To be in proper calibration, the values should be within the required tolerance band (typically 1.0 percent) for the asphalt cement supply system.

QUIZ

1. Using the calibration chart on page 4-20 and the information given below, determine the tons per hour of aggregate to be fed from each bin.

Design asphalt content: 6.5%
Plant production: 250 TPH
Aggregate blend at the cold feed:
Bin #1: 40%
Bin #2: 35%
Bin #3: 15%
Bin #4: 10%

	Aggregate Delivery (TPH)
Bin No. 1	
Bin No. 2	
Bin No. 3	
Bin No. 4	

See page 4-25 to check your answers.

That's it for Chapter Four. When you are ready, begin Chapter Five -- ASPHALT PLANT DOCUMENTATION.

ANSWERS TO QUESTIONS

Page 4-11 to 4-12

1. D
2. B
3. C
4. A. Full coating of the aggregates
   B. Avoiding contact with the burner flame
5. A; C

Page 4-15

1. cold feed gates and belts; weight-in-motion scale
2. weight-in-motion scale
3. aggregate delivered; belt speed
4. manufacturer's recommendations

Page 4-24

1. Bin No. 1 93.5 TPH
   Bin No. 2 81.8 TPH
   Bin No. 3 35.1 TPH
   Bin No. 4 23.4 TPH

CHAPTER FIVE

Asphalt Plant Documentation

CONTENTS

ASPHALT PLANT DOCUMENTATION

In this chapter, we will address the responsibilities and records for documenting plant activities. Some of the forms in this chapter were discussed elsewhere in this course or in the Asphaltic Concrete Testing course. This chapter does not include the details about form completion but provides a summary of the overall requirements for plant documentation. Florida Department of Transportation (FDOT) asphalt forms and instructions are managed by the Organization, Forms and Procedures Office and can be found through the State Materials Office Infonet/Internet web-site at:

http://www2.dot.state.fl.us/proceduraldocuments/internet/formsbyofficedetail.asp?office=MATERIALS

CONTRACTOR'S RECORDS

GENERAL RESPONSIBILITIES

On asphalt projects in Florida, the contractor has as much responsibility for documentation as the FDOT does. The Contractor's Quality Control Technician must document all quality control sampling and testing and the contractor must complete all required documentation and turn it over to the Department.

FORMS

The Department has developed formats for all necessary forms, both for Contractor's Quality Control Testing and Department's Verification and Resolution Testing. The Department furnishes daily quality control forms for the contractor to use and maintain asphalt plant quality control records. To accomplish this the contractor must complete the Asphalt Plant - Daily Report of Quality Control form which is included on the following page.

State Of Florida Department Of Transportation

675-030-15
MATERIALS
07/02

Asphalt Plant - Daily Report of Quality Control

Date 1 Page No. 2 of

Fin. Project ID: 3 Material No.: 4 Sample No.: 5 Date Smpl: 6

Sta. From: 7 Sta. To: 8 Reference Line: NA Source: 05 Plant No.: 9 Quantity: 10

Intended use: 11 Inspec ID (TIN): 12 Date Recd: 13 Date Tested: 14

Tested by Code: 15 Status: 16 Tester ID (TIN): 17 Type of Mix: 18 Mix Design No.: 19

See Asphalt Roadway - Daily Report(s) of Quality Control for Pay-Item Information

General Information

Temperature °F / °C		Quantity	This Material Tons	This Lot Tons
Established	20	Previous	25	30
Average	21	Todays	26	31
Maximum	22	Total	27	32
Minimum	23	Waste	28	33
Average of 1st 5	24	Adj. Total	29	34

Blend Type Check one

MATL. #453B Site 35

MATL. #452B Storage 36

Rotational Viscosity for Asphalt Rubber Binder

Asphalt Rubber Grade 37

Test Temp. 38 °F/°C °F/°C

Minimum Viscosity 39 AM PM

40 poises Pa.s poises Pa.s

Plant Volumetrics

Gradation and AC Content	Mix Design Targets	LOT/SUB	LOT/SUB 41	LOT/SUB
1" (25.0mm)	42		43	
3/4" (19.0mm)				
1/2" (12.5mm)				
3/8" (9.5mm)				
#4 (4.75mm)				
#8 (2.36mm)				
#16 (1.18mm)				
#30 (600 µm)				
#50 (300 µm)				
#100 (150 µm)				
#200 (75µm)				
AC %				

Volumetrics	Mix Design Targets	LOT/SUB	LOT/SUB 41	LOT/SUB
Gmm	42		44	
Avg. Bulk (Gmb)				
Hgt. @ N int.				
Hgt @ N des.				
Gyrations				
% Gmm @ N int.				
% Gmm @ N des.				
% Air Voids @ Nd				
% VMA @ Nd				
% VFA @ Nd				
Dust / Asphalt				

Roadway Cores				
	Roadway Core 1		45	
	Roadway Core 2			
	Roadway Core 3			
	Roadway Core 4			
	Roadway Core 5			
	Average Gmb			
	% Gmm			

46
Qualified Technician Signature

Remarks: 47

5-3

QUIZ

On the Asphalt Plant - Daily Report of Quality Control form what goes in:

1. Block 9: _____

2. Block 20: _____

3. Block 37: _____

4. Where do you get the lot/sublot (LOT/SUB) information? _____

5. Where do you get the Average Mix temperature? _____

6. Where is the Roadway Core G_{mb} Data recorded? _____

Check your answers on page 5-16. If you got the right answers continue on to MIX DESIGN, if not go back over the material.

MIX DESIGN

The contractor designs hot mix for a project, with the exception of open-graded friction mixes (FC-5). The mix design is submitted to the State Materials Office at least three weeks prior to the anticipated starting time for the production of the mix, and to the appropriate District Bituminous Engineer to inform him that the mix is to be produced in the near future.

The contractor submits both the front and the back pages of the mix design.

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

SUBMIT TO THE STATE MATERIALS ENGINEER, CENTRAL BITUMINOUS LABORATORY, 2006 NORTHEAST WALDO ROAD., GAINESVILLE, FLA. 32609

Contractor: Superpavers Asphalt Contracting Address: 2006 NE Waldo Road, Gainesville, Florida

Phone No.: 352-337-3100 Fax No.: 352-337-3239 E-mail: FDOT@dot.state.fl.us

Submitted By: Superpavers Asphalt Contracting Type Mix: Fine SP-12.5 Recycle Intended Use of Mix: Structural

Design Traffic Level: D Gyrations @ N des: 100

TYPE MATERIAL	F.D.O.T. CODE	PRODUCER	PIT NO.	DATE SAMPLED
1. Milled Material		222222-1-52-01 Top 2.5" NB & SB KmP. 0.000 - 3.000 / M.P. 0.000 - 1.864	Roadway	05 / 01 / 2002
2. 67 Stone	43	Superior Aggregate Company	99-111	05 / 01 / 2002
3. 89 Stone	53	Superior Aggregate Company	99-111	05 / 01 / 2002
4. Screenings	21	Superior Aggregate Company	99-111	05 / 01 / 2002
5.				
6.				

PERCENTAGE BY WEIGHT TOTAL AGGREGATE PASSING SIEVES

	Blend Number	15% 1	30% 2	40% 3	15% 4	5	6	JOB MIX FORMULA	CONTROL POINTS	RESTRICTED ZONE
SIEVE SIZES	3/4" 19.0mm	100	100	100	100			100	100	
	1/2" 12.5mm	87	70	100	100			91	90 - 100	
	3/8" 9.5mm	94	36	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 600µm	47	3	5	48			17		19.1 - 23.1
	No. 50 300µm	28	2	3	28			10		
	No. 100 150µm	14	2	3	18			7		
	No. 200 75µm	8.0	1.0	2.0	7.0			5.0	2 - 10	
	G_{sb}	2.562	2.393	2.448	2.581			2.467		

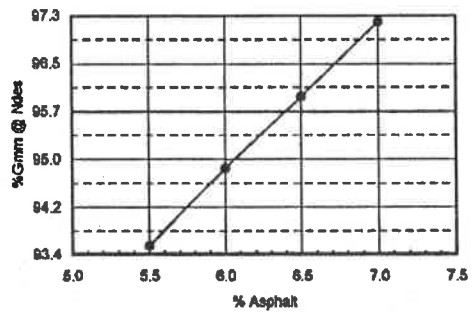
No. 200 reflects aggregate changes expected during production.

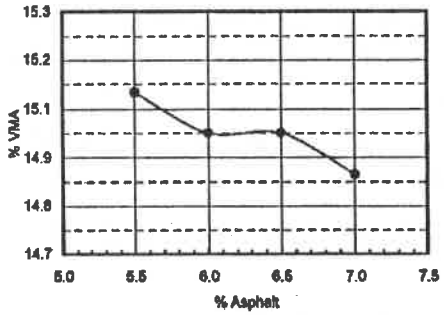
State Materials Engineer: [signature]
Original document retained at the State Materials Office
Effective Date: 07 / 23 / 2002
Expiration Date: 07 / 23 / 2004

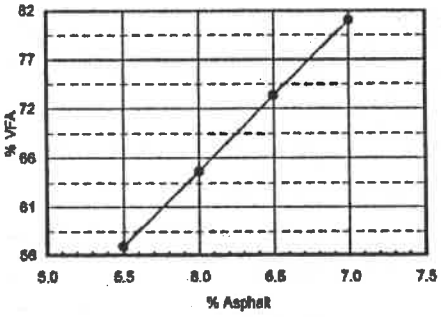
http://materials.dot.state.fl.us/Smo/Bituminous/CentralBitLab/CentralBituminousLab.htm

HOT MIX DESIGN DATA SHEET

P_b	G_{mb} @ N_{des}	G_{mm}	V_a	VMA	VFA	P_{be}	$P_{0.075}$ / P_{be}	%G_{mm} @ N_{ini}	%G_{mm} @ N_{max}
5.5	2.217	2.370	6.5	15.1	57	4.0	1.3	87.5	93.9
6.0	2.232	2.354	5.2	15.0	65	4.5	1.1	88.3	95.3
6.5	2.244	2.338	4.0	15.0	73	5.0	1.0	88.9	96.5
7.0	2.257	2.322	2.8	14.9	81	5.5	0.9	89.8	98.0







Optimum Asphalt 6.5 % FAA 46 % Mixing Temperature 300 °F 149 °C
Antistrip R-US 50-00 (D000)

Lab. Density 140.0 Lbs/Ft^3 2244 Kg/m^3 %G_{mm} @ N_{des} 96.0 Additives Antistrip 0.5 %

VMA 15.0 % NCAT Oven Calibration Factor 0.05 %
(+To Be Added)/(-To Be Subtracted)

Optimum Asphalt = 6.5%
Asphalt using 15% Milled Material @ 5.5% = 0.8%
PG 67-22 to be added = 5.7%

The specifications require the contractor to provide the following information for a design mix for verification:

1. The specific project on which the mixture will be used (for accounting purposes)
2. The design traffic level and the design number of gyrations (N_{design})
3. The source and description of the materials to be used
4. The DOT source number and the DOT product code of the aggregate components furnished from a DOT approved source
5. The gradation and approximate proportions of the raw materials as intended to be combined in the paving mixture and the gradation of the component materials shall be representative of the material at the time of use. Compensate for any change in aggregate gradation in handling and processing as necessary
6. A single percentage of the combined mineral aggregate passing each specified sieve and the degradation of the aggregate due to processing (particularly -No. 200 [-75 μm]) should be accounted for and identified for the applicable sieves
7. The bulk specific gravity value for each individual aggregate (and RAP) component, as identified in the Department's aggregate control program
8. A single percentage of asphalt binder by weight of total mix intended to be incorporated in the completed mixture, shown to the nearest 0.1%
9. A single temperature at which the mixture is intended to be discharged from the plant and a target roadway temperature. Do not exceed a target temperature of 340°F (170°C) for modified asphalts and 315°F (157°C) for unmodified asphalts
10. Evidence that the completed mixture will conform to all specified physical requirements
11. The name of the Construction Training Qualification Program (CTQP) Qualified Mix Designer
12. The ignition oven calibration factor(s)

After the State Materials Office verifies the mix, it signs and dates the forms, gives the mix a number, issues copies of the design mix to all interested parties and posts it on the Department's Infonet.

QUIZ

On the Mix Design form:

1. Does the contractor have to provide an ignition oven calibration factor? _____

2. For the mix design shown on pages 5-6 and 5-7, what is the optimum asphalt content? _____

3. For the mix design shown on pages 5-6 and 5-7, what is the percent of 89 stone? _____

4. For the mix design shown on pages 5-6 and 5-7, what is the VMA at 6.5 % asphalt? _____

Check your answers on page 5-16. If you got the right answers continue, if not go back over the material.

Now we will discuss DEPARTMENT OF TRANSPORTATION RECORDS.

DEPARTMENT OF TRANSPORTATION RECORDS

VERIFICATION TESTS

Verification tests include:

- Asphalt binder content
- Air Voids at N_{design}
- Percent passing No. 8 sieve (2.36 mm)
- Percent passing No. 200 sieve (75 μm)
- Roadway Core Bulk Specific Gravity (G_{mb})

These tests usually are run on the same sample and documented on several forms, "Asphalt Plant - Ignition Oven Worksheet; Asphalt Plant - Bulk Specific Gravity Worksheet; Asphalt Plant - Maximum Specific Gravity Worksheet". These forms cover four sublot samples, which normally comprise a lot. A detailed discussion of these worksheets is included in the Introduction to Hot Mix Asphalt Testing Self Study.

FORMS

The Department's CTQP qualified Plant Technician is responsible for documenting verification tests and general plant activity. To accomplish this he must complete the Asphalt Plant - Verification Report form which is included on the following page.

State Of Florida Department Of Transportation

675-030-19
MATERIALS
07/02

Asphalt Plant - Verification Report

Page No. 1 of ____

Fin. Project ID: 2 | Material No.: 3 | Sample No.: 4 | Date Smpl: 5

Sta. From: 6 | Sta. To: 7 | Reference Line: NA | Source: 05 | Plant No.: 8 | Quantity: 9

Intended use: 10 | Inspec ID (TIN): 11 | Date Recd: 12 | Date Tested: 13

Tested by Code: 14 | Status: 15 | Tester ID (TIN): 16 | Type of Mix: 17 | Mix Design No.: 18

Plant Volumetrics

Gradation and AC Content	Mix Design Targets	Date 19 Lot/Sub 20	Lot/Sub	Lot/Sub	Lot/Sub
1" (25.0mm)	21			22	
3/4" (19.0mm)					
1/2" (12.5mm)					
3/8" (9.5mm)					
#4 (4.75mm)					
#8 (2.36mm)					
#16 (1.18mm)					
#30 (600 µm)					
#50 (300 µm)					
#100 (150 µm)					
#200 (75µm)					
AC %					
Gmm					
Avg. Bulk (Gmb)					
Hgt. @ N int.					
Hgt @ N des.					
Gyrations @ Ndes.					
%Gmm @ N int.					
% Gmm @ N des.					
% Air Voids @ Nd					
% VMA @ Nd					
% VFA @ Nd					
Dust / Asphalt					
Roadway Core 1 Gmb : month / day				23	
Roadway Core 2 Gmb : month / day					
Roadway Core 3 Gmb : month / day					
Roadway Core 4 Gmb : month / day					
Roadway Core 5 Gmb : month / day					
Average Roadway Core Gmb					
% Gmm					

Pay Factors

3/8' Sieve	24
No. 4 Sieve	
No. 8 Sieve	
No. 200 Sieve	
Percent AC	
Air Voids	
Density	
COMPOSITE	

Temperature Verification °F / °C

Established Mix Temperature 25

Date	Temperature	Load No.:
26	27	28

29 Qualified Technician Signature

Remarks: 30

QUIZ

On the Asphalt Plant - Verification Report what goes in:

1. Block 10: _____
2. Block 18: _____
3. Block 24: _____
4. Block 29: _____
5. Where do you get the sample number? _____
6. Where do you get the Inspector ID (TIN)? _____
7. Where are remarks recorded? _____

Check your answers on page 5-16. If you got the right answers continue on to OTHER QUALITY CONTROL DOCUMENTATION, if not go back over the material.

OTHER QUALITY CONTROL DOCUMENTATION

After calculating the acceptance test results, the Plant Technician posts them on the form, "Control Charts for Acceptance Tests". These are plotted and kept up-to-date.

Control charts are provided for the following:

a. Gradation of incoming aggregates
b. Gradation and asphalt content of RAP
c. Combined gradations of hot bins
d. Extracted asphalt content
e. Mix gradation
f. Gradation of cold feed (drum mixers)

These control charts are to be posted in the asphalt lab where they can be seen.

Also, the results of the volumetrics testing [air voids (Va), maximum specific gravity of the mix (G_{mm}), and the bulk specific gravity of the mix (G_{mb})] shall be provided and posted in the lab.

STATE OF FLORIDA DEPARTMENT OF TRANSPORTATION

FORM 675-030-02
MATERIALS
08/98

CONTROL CHARTS FOR ACCEPTANCE TESTS (Superpave Sieves)

FINANCIAL PROJECT ID _____ FAP NO. _____ DATE _____

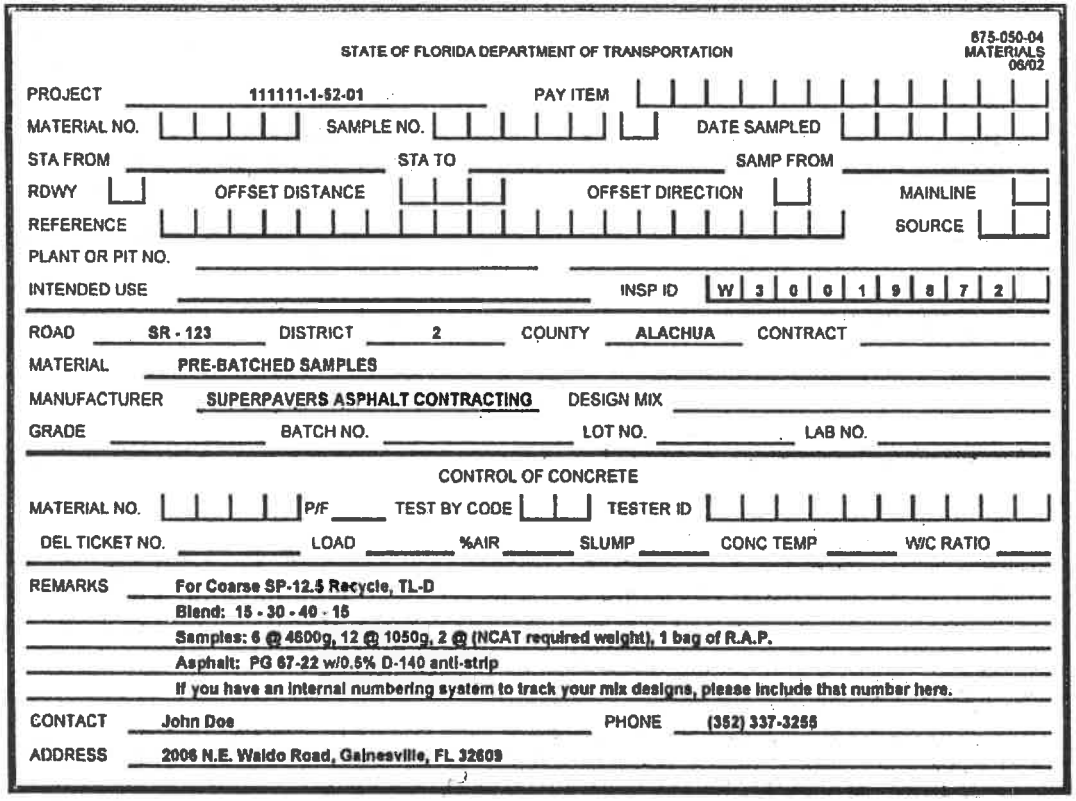
TYPE OF MIX _____ MIX DESIGN NO. _____ CHART NO. _____

	LOT NO. ____				LOT NO. ____				LOT NO. ____				LOT NO. ____				LOT NO. ____			
	Sublot				Sublot				Sublot				Sublot				Sublot			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
PERCENT ASPHALT TARGET ____																				
PERCENT PASSING No. 4 SIEVE 4.75 mm SIEVE TARGET ____																				
PERCENT PASSING No. 8 SIEVE 2.36 mm SIEVE TARGET ____																				
PERCENT PASSING No. 50 SIEVE 300 µm SIEVE TARGET ____																				
PERCENT PASSING No. 200 SIEVE 75 µm SIEVE TARGET ____																				

RECYCLED PAPER

SAMPLE TRANSMITTAL CARD

The "Sample Transmittal Card," provides general information for transmitted materials. An example of the card is shown below:



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.

INTENDED USE INSP ID W3006198721

ROAD SR - 123 DISTRICT 2 COUNTY ALACHUA CONTRACT

MATERIAL PRE-BATCHED SAMPLES

MANUFACTURER SUPERPAVERS ASPHALT CONTRACTING 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: 6 @ 4600g, 12 @ 1050g, 2 @ (NCAT required weight), 1 bag of R.A.P.
Asphalt: PG 67-22 w/0.5% D-140 anti-strip
If you have an internal numbering system to track your mix designs, please include that number here.

CONTACT John Doe PHONE (352) 337-3255

ADDRESS 2006 N.E. Waldo Road, Gainesville, FL 32609

ANSWERS TO QUESTIONS

Page 5-4

1. Plant Number
2. Established Mix Temperature
3. Asphalt Rubber Grade
4. Block 41
5. Block 21
6. Block 45

Page 5-9

1. Yes
2. 6.5%
3. 40 %
4. 15.0 %

Page 5-12

1. Intended Use
2. Mix Design Number
3. Pay Factors
4. Qualified Technician Signature
5. Block 4
6. Block 11
7. Block 30

CONGRATULATIONS

You have finished the course in Hot Mix Asphalt Plant Inspection. Before you take the Examination, however, there are a few things you should do:

1. Put this book away for a day or so -- to let the information settle in your mind.
2. Take the Review Quiz (Chapter Six).
3. Go back into the course and study the sections that gave you trouble in the Review Quiz.
4. When you feel you are ready, tell your Supervisor that you want to take the exam.

CHAPTER SIX

Review Quiz

Things which you have learned in this course are going to help you do a better job as a Plant Technician. 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 Five 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 two hours.
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 abbreviation for Hot Mix Asphalt is _____.

2. What are the two ingredients of hot mix?_____ and _____

3. A slight difference in the asphalt content and in the size of the aggregate particles can change the properties of the hot mix.
   True or false? _____

4. The range and relative distribution of particle sizes in the aggregate material is called _____.

5. Stockpiles must be separated by space or solid partitions to prevent the _____ of the different size aggregates.

6. Stockpiling methods that result in contamination or excessive degradation should _____.

7. The Plant Technician's primary duty is to see that a uniform mix, meeting specifications, is turned out at the plant.
   True or False? _____

8. The Plant Technician must ensure that the plant is maintained in a satisfactory condition.
   True or False? _____

9. When asphalt is delivered to the plant, you must verify what three items?

   _____

   _____

   _____

10. What does certification mean? _____

11. Routine inspection of the _____ and the _____ assure a steady flow of properly proportioned aggregates to the dryer.

12. Cold bins must be arranged to provide complete separation of the aggregate sizes.
True or False? _____

13. In calibrating cold feed gates, all gates must be closed except the gate that is going to be calibrated.
True or False? _____

14. Gradation control begins with the _____.

15. The two functions of the dryer are _____ and _____.

16. The feeders must provide a steady flow of aggregate, within the capacity of the dryer.
True or False? _____

17. The baghouse dust collector works by forcing the dust-filled air through _____.

18. A pyrometer must continuously show the temperature of the aggregates leaving the _____.

19. All aggregates are usually heated to the temperature range of 275°F to 325°F. The asphalt should be heated to between 250°F and _____.

20. The hot elevator carries the aggregates from the _____ to the _____ units.

21. The _____ screen prevents objectionable material from entering the hot bins.

22. The _____ separate the hot aggregates into the specified sizes, which are then stored in the _____ _____.

23. Aggregates that do not pass through the openings in the scalping screens are _____.

24. Hot bin screen sizes and arrangements depend on the gradation requirements of the mix.
True or False? _____

25. List the operations that directly affect the gradation of aggregates in the finished mix.
A. _____
B. _____
C. _____
D. _____
E. _____

26. Partitions between the hot bins should be high enough and free from holes to prevent the various sized aggregates from mixing.
True or False? _____

27. Hot bin gates must close tightly to prevent leakage into the _____.

28. The weigh box must be ample in size to hold a full _____.

29. It is the Plant Technician's responsibility to ensure that the aggregate scale is accurate.
True or False? _____

30. The weigh box gates are inspected to ensure that the gates close tightly.
True or False? _____

31. Asphalt scale dials usually are graduated at _____ pound intervals.

32. Aggregate scale dials usually are graduated at _____ pound intervals.

33. The asphalt weigh bucket capacity should be at least _____ percent in excess of the weight of the asphalt required in any batch.

34. Aggregate scales must be certified by a _____.

35. The aggregate scale must be certified at least every _____.

36. Batch plant pugmill paddles must produce a circular or _____ action.

37. The Plant Technician must ensure that a uniform mix is being produced in the pugmill.
True or False? _____

38. The pugmill must be equipped with _____ shafts.

39. The condition and arrangement of the paddles, as well as non-clogging of the spray openings, are important for a uniform mix.
True or False? _____

40. Uniform coating of the aggregates with asphalt is not possible if the pugmill is either underfilled or overfilled.
True or False? _____

41. The discharge gate at the bottom of the pugmill must close tightly to prevent leakage during mixing.
True or False? _____

42. The asphalt enters the pugmill through a _____ or a _____.

43. The proper amount of asphalt for one batch is weighed out in the weigh _____.

44. The asphalt is automatically sprayed into the pugmill at the end of the _____ mixing period.

45. The wet-mixing period begins when _____.

46. In a batch plant, one batch is mixed while the components of the next batch are weighed out.
True or false? _____

47. After taking the temperature of the first five loads of the day, check the temperature of every _____ truckload of mix and record temperature on the _____.

48. Technicians must ensure that haul trucks have a clean, tight and smooth metal body and that _____ are used to protect the hot mix from the weather.

49. Hot mix ingredients are proportioned by _____ in a batch plant.

50. The batch weight from Bin No. 3 is 680 lbs. The batch weight from Bin No. 2 is 1,150 lbs. Material from Bin No. 3 is weighed first, then material from Bin No. 2 is weighed.

    The first marker is placed at _____

    The second marker is placed at _____

51. Where is aggregate temperature measured?_____

Use the following information for answering the next three questions:

- Batch size is 8,000 pounds.
- Asphalt cement % is 6.5%
-

Bin No.	Trial %
3 Coarse aggregates	34
2 Medium coarse aggregates	28
1 Fines	38

(The hot bins are pulled in the order shown: 3,2,1.)

52. What is the cumulative weight for Bin 2? _____ pounds

53. What is the weight for Bin 3? _____ pounds

54. What is the individual weight for A.C.? _____ pounds

55. The following items are steps used to reestablish pull weights when gradations are out of tolerance. Arrange them in the proper order, using numbers 1 through 4:

___ Calculate the new percentages of each size aggregate based on the total mix. Based on the new mix percentages, recalculate the weights to be pulled from each bin and record the data.

___ Set the scale markers on the newly determined cumulative weights.

___ Select the hot bin percentages you feel would make the total gradation compare favorably with the Job Mix Design. Using a gradation worksheet, calculate the percentage passing.

___ If the gradations compare favorably with the Job Mix Design -- go to Step 3. If not, repeat Step 1 until a favorable comparison is obtained.

56. In the cold aggregate supply system of a drum-mix plant, particular care is needed in controlling ... (Circle one or more)

A. the stockpiles.
B. the cold bins.
C. the proportioning of the aggregates.
D. All of the above

57. On most drum-mix plants, if the rate of aggregate flow is increased, the asphalt flow will ... (Circle one)

A. remain the same.
B. be automatically decreased.
C. be automatically increased.
D. be manually increased or decreased depending on the temperature of the mix.

58. The two primary considerations in determining where the asphalt spray is positioned in the parallel flow drum are:

A. _____ and

B. _____

59. Which of the following drum-mixer adjustments would be more practical after production has started? (Circle one or more)

A. Adjusting the burner flame

B. Changing the angle of the drum

C. Adjusting the aggregate and asphalt flow rates

D. Any of the above

60. Is the AC% recorded on the Asphalt Plant - Daily Report of Quality Control? _____

61. Are batch weights and percentages recorded on the Asphalt Plant - Daily Report of Quality Control? _____

SCORE YOUR OWN REVIEW QUIZ

The Review Quiz contains, approximately, 78 possible answers; they start on the next page. If you scored 90% or better -- that's 70 or more correct answers --you should be ready for the Examination.

If you had 8 or more wrong answers, take the course again -- and spend more time studying the things that give you trouble. After you have retaken the course, work the Review Quiz again. Your score should be at least 90%.

Good luck on the Examination.

ANSWERS TO QUESTIONS

1. HMA
2. aggregate; asphalt cement
3. True
4. gradation
5. mixing
6. not be allowed
7. True
8. True
9. certification
   delivery ticket
   additives (if required)
10. That the material met specifications
11. cold bins; cold feed
12. True
13. True
14. cold feed
15. heating; drying
16. True
17. cloth bags
18. dryer
19. 325°F
20. dryer; screen deck
21. scalping
22. screens; hot bins
23. rejected
24. True
25. A. stockpiling
    B. cold feed
    C. screening
    D. weighing
    E. mixing
26. True
27. weigh box
28. batch
29. True
30. True
31. 1
32. 5
33. 10
34. certified scale technician
35. six months
36. runaround
37. True
38. two
39. True
40. True
41. True
42. spray bar; trough
43. bucket
44. dry
45. the asphalt binder is first added to the pugmill
46. True
47. fifth; delivery ticket
48. covers (or tarpaulins)

49. weight
50. 680 pounds; 1,830 pounds
51. Discharge end of dryer
52. 4,637
53. 2,543
54. 520
55. 3; 4; 1; 2
56. D
57. C
58. A. Full coating of the aggregates
    B. Avoiding contact with the burner flame
59. A; C
60. Yes
61. No