CHAPTER 3
ASPHALT CONCRETE PLANTS

Asphalt Concrete mixes made with asphalt cement are prepared at an asphalt mixing plant. Here, aggregates are blended, heated, dried, and mixed with asphalt cement to produce a hot mix asphalt (HMA). This chapter discusses the two most common types of asphalt plants.

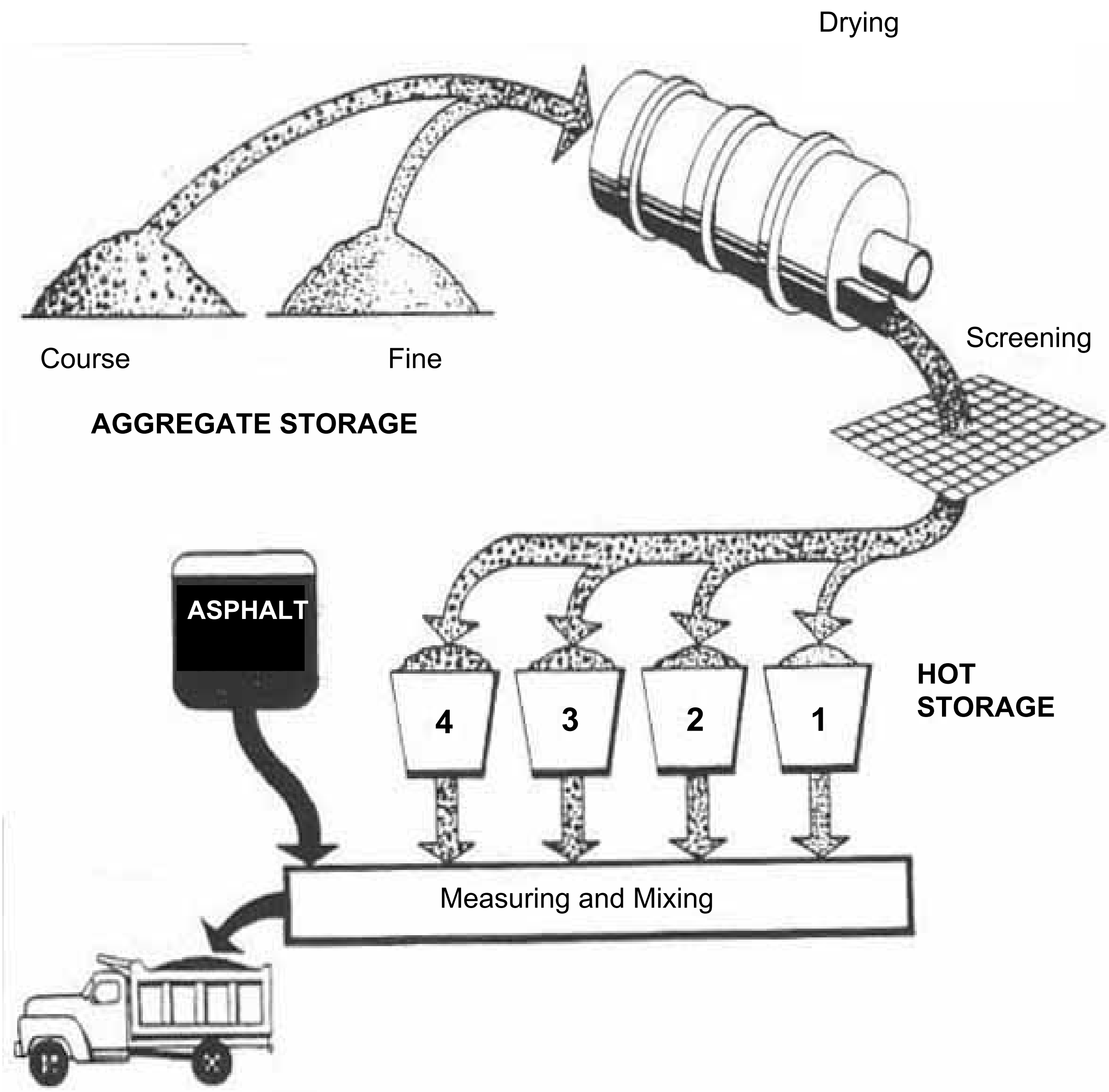
Asphalt Concrete plants are basically of two types, batch or drum mix. The two types of asphalt plants derive their names from their particular type mixing operation. In the batch-type mixing plant, hot aggregate and asphalt are withdrawn in desired amounts to make up one batch for mixing. After thoroughly mixing, the material is discharged from the pugmill in one batch. In the drum-type mixing plant, the aggregate is dried, heated, and mixed with the asphaltic cement in the drum in a continuous operation.

Batch Type Plant

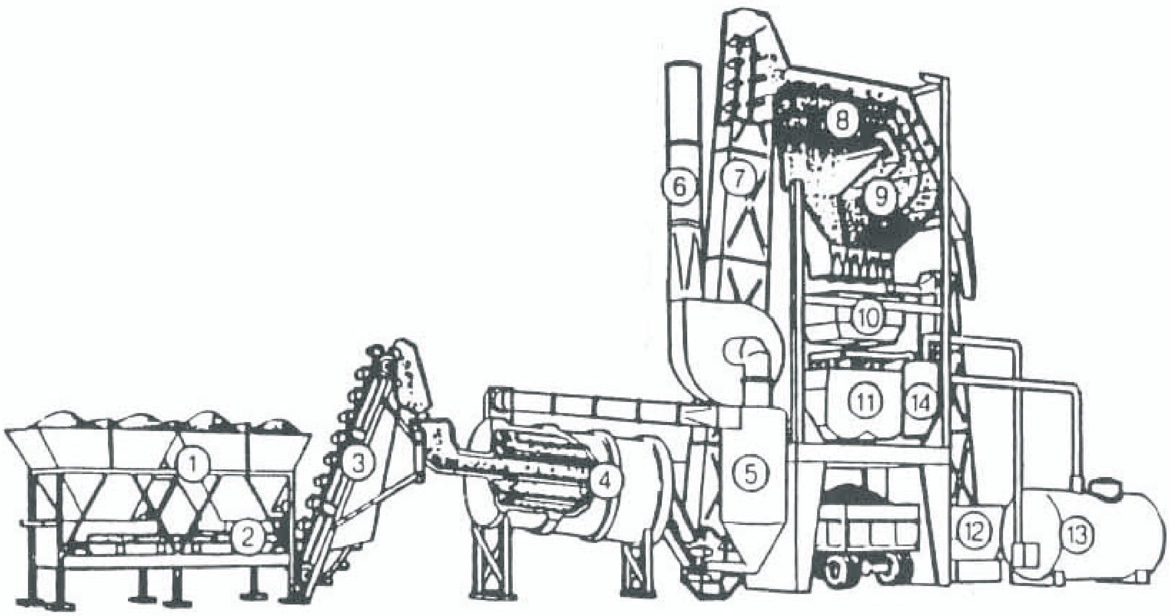
Flow diagram of a batch-type asphalt plant (Figure 3-1):

a) cold aggregate feed
b) drying
c) screening
d) hot storage
e) measuring and mixing

Aggregate is removed from storage, or stockpiles, in controlled amounts and passed through a dryer where it is heated and dried. The aggregate then passes over a screening unit that separates the material into different size fractions and deposits them into bins for hot storage. The aggregate and mineral, when used, are then withdrawn in controlled amounts, to make up one batch for mixing (Figure 3-1). The entire combination of aggregate is dumped into a mixing chamber called a pugmill. Then the asphalt, which has also been weighed, is thoroughly mixed with the aggregate in the pugmill. After mixing, the material is emptied from the pugmill in one batch.



Typical Asphalt Concrete Batch Plant
Figure 3-1



1. Cold bins
2. Cold feed gate
3. Cold elevator
4. Dryer heater
5. Dust collector
6. Exhaust stack
7. Hot elevator
8. Screening unit
9. Hot bins
10. Weigh box
11. Mixing bowl or pugmill
12. Mineral filler storage
13. Hot bitumen storage
14. Bitumen weigh box

Components of an Asphalt Concrete Batch Plant
Figure 3-2

Components of an Asphalt Concrete Batch Plant

Cold Feed Supply

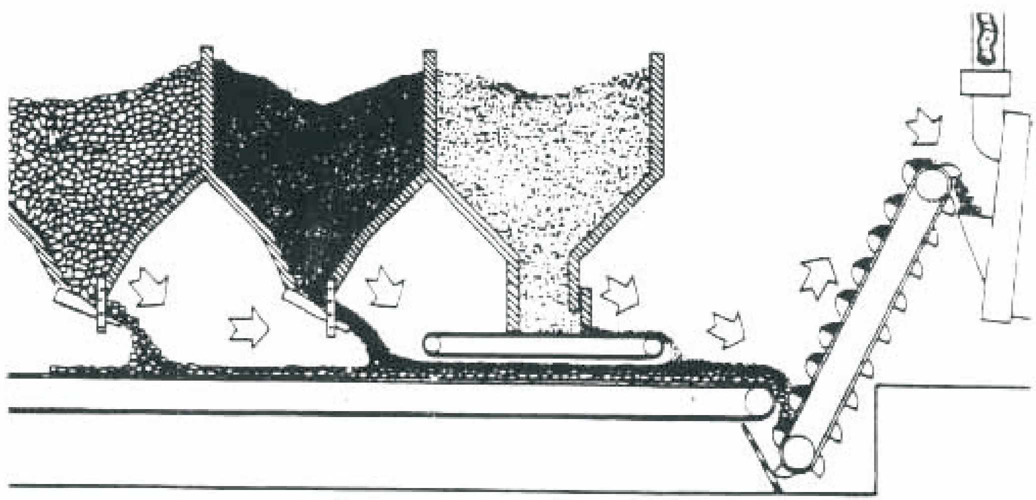
Cold aggregate feed is the first major component of the batch-type asphalt concrete plant. The cold feeder may be charged by one or a combination of the following methods:

1. Open top bins with two, three, or four compartments, usually fed by a crane with a clamshell bucket or a front-end loader.
2. Tunnel under stockpiles separated by bulkheads. Materials are stockpiled over the tunnel by belt conveyor, truck, crane, or front-end loader.
3. Bunkers or large bins. These usually are fed by trucks, car unloaders, or bottom-dump freight cars, which empty directly into the bunkers.

The cold aggregate feed is one of the critical control points in the production flow-line. It is significant that, while most of the problems in asphalt concrete production occur in the dryer, on the plant screed, in the bins, or in the pugmill, the causes can usually be traced back to the cold feed. When charging the cold feed, care should be exercised to minimize segregation and degradation of the aggregate. This can be prevented by taking the same precautions outlined for proper stockpiling.

Types of Feeders and Controls

Aggregate feeder units (Figure 3-3) are located beneath the storage bins or stockpiles, or in positions that assure a uniform flow of aggregate. Feeder units have controls that can be set to produce a uniform flow of aggregate to the cold elevator. Generally belt and vibratory feeders are best for accurate metering of the fine aggregates. Course aggregates usually flow satisfactorily with any type of feeder. For a uniform output from the asphalt concrete plant, input must be accurately measured. The importance of feeding the exact amounts of each size aggregate into the dryer at the correct rate of flow cannot be overemphasized.



Three-Bin Cold Feeder and Belt
Figure 3-3

Lime Dispersion

When lime is used in asphalt concrete, it must be mixed by pugmill or other approved means to achieve a uniform lime coating on the aggregate prior to adding the asphalt cement to the mixture. The method of introducing and mixing the lime and aggregate shall be subject to approval by the Engineer prior to beginning production.

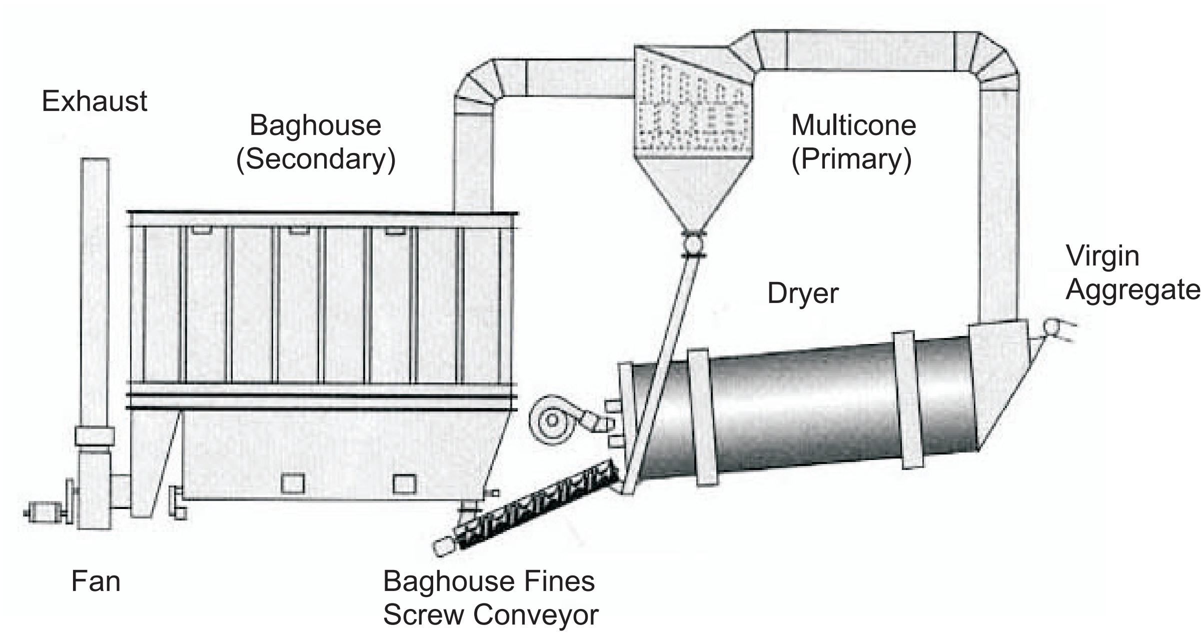
The Dryer

One of the basic units in any asphalt concrete plant is the dryer. It is a necessary part of the hot-mix operation for it dries and heats aggregates coming from the cold feed supply, thus making them suitable for mixing with asphalt. The dryer is usually a large rotating metal drum mounted at an angle and equipped with a gas or oil-heating unit at the lower end . Hot gases from the burner pass from the lower end of the rotating drum and out the upper end. Cold aggregate is fed into the upper end of the dryer and is picked up by steel angles or flights mounted on the inside of the unit. As the drum rotates, the aggregate is lifted up and dumped through hot gases. Because of the inclination, the aggregate also gradually works its way toward the lower end of the dryer. The hot aggregate then discharges from the lower end onto a hot elevator that carries it to the screens and hot storage.

Drying is the most expensive operation in mix production. It is also the most frequently encountered bottleneck in the plant operation. The best dryer is the one that meets a desired performance level at the lowest investment and operating cost. Most dryers are designed for average aggregate moisture content. Very wet aggregate will reduce the dryer capacity and require corrective measures.

Temperature Indicating Device

Aggregate temperature is measured by either a thermometer or a thermocouple attached to an indicating pyrometer. Pyrometers react much faster to changes in temperatures and are usually preferred. An aggregate heat measuring device should be installed in the dryer discharge in full view of the burner operator. This device is one of the most important plant control accessories and should be a reliable and accurate instrument. Overheating of the aggregate can damage the asphalt during mixing, under heating makes the aggregate difficult to coat with the asphalt and difficult to place.



Dryer with Primary and Secondary Dust Collector
Figure 3-4

The Dust Collector

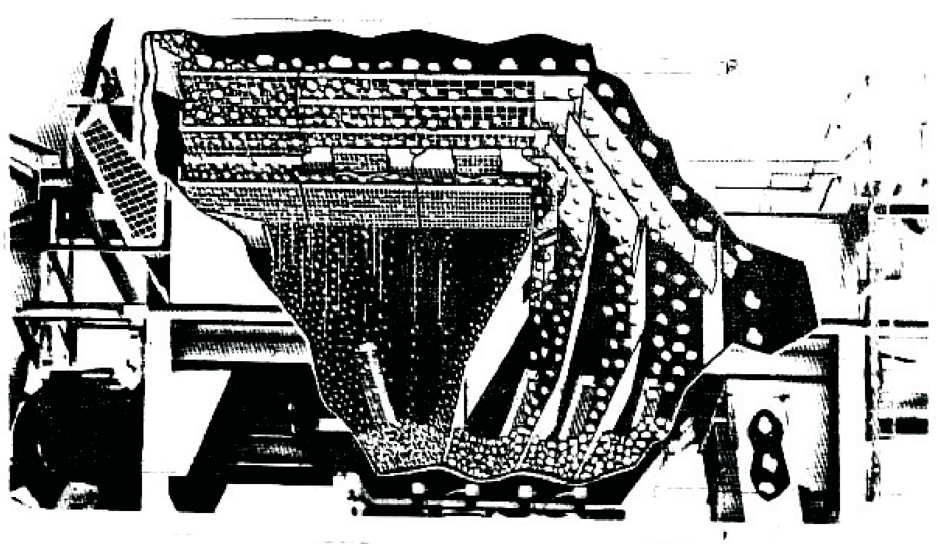
The dust collector (Figure 3-4) is generally operated adjacent to and in conjunction with the dryer, and is necessary for efficient plant operation. The collector eliminates or abates the dust nuisance that might result from exhaust air from the dryer. Modern dust-collection systems are highly efficient. Provisions are usually made in the dust collecting system to return the collected dust back to the hot aggregate as it emerges from the dryer and picked up by the hot elevator. If the collected dust is unsuitable for use in the asphalt concrete mixture, it may be removed from the collector and wasted. The dust collector fan(s) furnishes the draft that draws the flame and hot gases through the dryer. Dust particles from the dryer and other parts of the plant are also carried in the current of draft air, which enters the dust collector at the upper periphery and goes into vertical motion. The heavier dust particles in the air stream are separated by centrifugal force into the collector shell and fall to the bottom. The finer dust may remain in suspension and be carried out the exhaust stack with the air.

A wet wash system may be added to the dust collecting system to reduce the amount of fine dust being carried out the exhaust stack with the air. There are several types of wet systems, but they all usually consist of a short tower, with or without baffles. Exhaust from the dust collector enters the tower at the bottom and passes upward through a series of water sprays that remove the dust. Use of a wet wash system usually will increase fan requirements by 10 to 15 percent because of the pressure loss in the tower.

Screening Unit

Dried aggregates are generally transported from the dryer by a hot elevator and deposited onto a screening unit that is mounted over the plant bins. The function of hot screens is to accurately separate the aggregate into the specified sizes. (Figure 3-5). To properly perform this function, the effective screening area must be large enough to handle the maximum feed. Therefore, the capacity of the screens should be checked against the capacity of the dryer. The technician should observe the screens in operation to be sure they can handle the maximum feed.

The condition and cleanliness of the screens will, to a large extent, control their efficiency. Excessive wear of the screen wire causes enlarged openings resulting in oversize material in the bin. If the effective screening area is reduced by plugged screen openings, or if more material is fed to the screens than they can handle, the usual result is "carry-over." Carry-over is the depositing of finer material in a bin that should contain the next larger size aggregate. When carry-over fluctuates, lack of uniformity in the aggregate gradation will cause a corresponding lack of uniformity in the mixture. Carry-over increases the amount of fine aggregate in the total mix, and since fine aggregate has much more surface area per unit of weight requiring asphalt coating, this condition should be kept at a minimum. Excessive carry-over, or its fluctuations, will be apparent from the sieve-analysis made from the contents of the individual hot bins. Daily visual inspection of the screens for cleanliness is recommended, preferably before the start of the day's operations.



Cutaway View Showing Flow of Material Through Screens
Figure 3- 5

Hot Bins

Hot bins are used to temporarily store heated and screened aggregate in the various size fractions required. Each bin should be large enough to prevent depletion of the material when the mixer is operating at full capacity. Each bin should have an overflow pipe to prevent aggregate from backing up into the other bins. The overflow pipe also prevents overfilling to the point where the vibrating screen will ride on the aggregate. Should this happen, it would result in a heavy carry-over and probably damage the screens. The overflow vents should be checked frequently to make sure that they are free flowing and thus preventing contamination by intermingling from adjacent bins.

Material is withdrawn from the hot bins in predetermined proportions and at a specified rate. If the level of aggregate in hot storage has little variation during plant operation, a balanced flow of aggregate is being achieved. Plant bins hold the heated, screened aggregate in various size fractions required. Their partitions should be tight, free from holes, and of sufficient height to prevent intermingling of aggregates.

Mineral Filler

Some asphalt concrete plants often have a separate feeding system for the addition of mineral filler to the mix. The mineral filler is supplied in paper sacks or in bulk. The filler is placed into a ground-mounted feeder and conveyed into a surge hopper, where it is added to the aggregate as it leaves the hot bins. Mineral filler is added as an unheated material. When filler is used, the hopper must be emptied at the end of the day and kept dry to prevent caking of the filler.

Aggregate Weigh Hopper

Aggregates are released from the hot bins into the weigh hopper, generally beginning with the largest size aggregate and progressing down to the finest size, with the mineral filler usually, if used, sandwiched between the larger aggregates. The amount from each bin is determined by the batch size and the proportions or percentages required to be blended. Determining hot bin pull weights will be discussed later in this school. The weigh hopper is suspended from a scale beam and the amounts of aggregate weighed cumulatively. Before withdrawal starts, there should always be sufficient materials in the hot bins for a complete batch. If a bin is near depletion or is running over, chances are that an adjustment in the cold feed is required.

Asphalt Bucket and Meter

Asphalt may be weighed in a special bucket, or it may be measured by a meter for each batch. When weighed into a batch, asphalt is pumped into a bucket of known weight and weighed on a scale. When metering devices are used, a volumetric measurement is made. The volume of asphalt changes with temperature. Some asphalt meters have built in temperature-compensating devices that correct the flow of asphalt when changes in temperature occur. The volume of asphalt pumped between two-meter readings may be weighed as a means of calibrating the meter.

Truck and Plant Scales

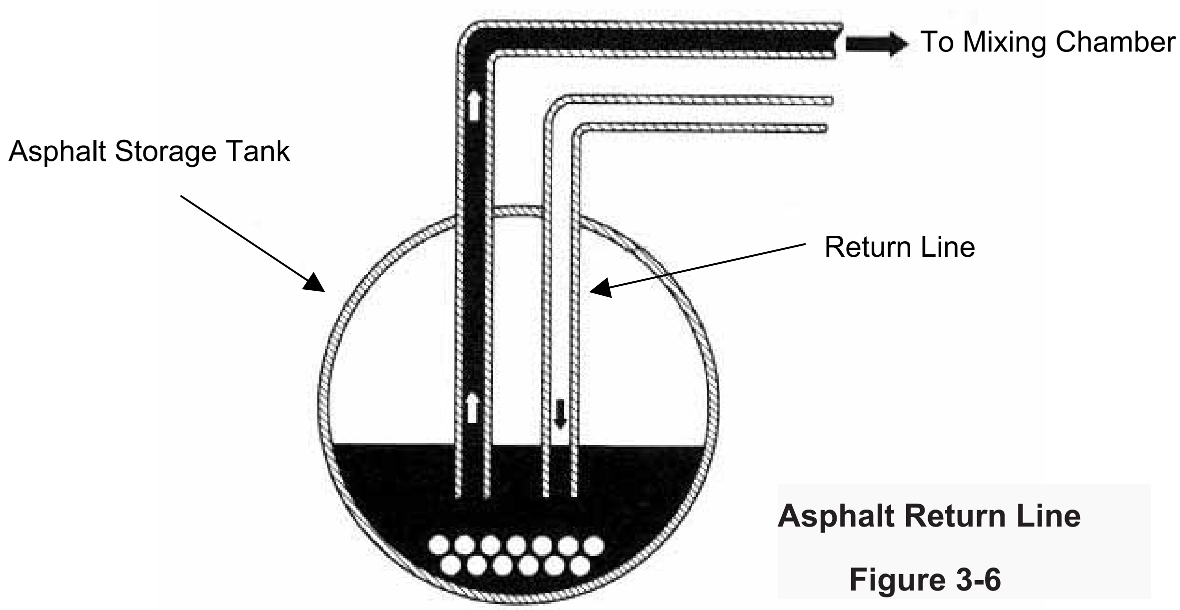
Scales used in the weighing of materials paid for on a tonnage basis shall be approved and sealed in accordance with the requirements of the policies of the *Bureau of Weights and Measures of the Department of Agriculture and Consumer Services,* or other approved agencies, at least once every six months and upon being moved. Hopper and truck scales shall be serviced and tested by a scale service representative at least once every six months. Hopper scales shall be checked with a minimum 500 pounds of test weights and truck scales shall be checked with a minimum 20,000 pounds of test weights. (Section 109.01)

Asphalt Storage

Asphalt storage at the plant should be equal to one day's output, and storage tanks should be calibrated so the amount of material remaining in the tank can be determined at any time. Since asphalt must be fluid enough for movement through the delivery and return lines, it must be heated. Heating may be done by the circulation of steam or hot oil through coils in the tank, or it may be done electrically.

NOTE: If the asphalt temperature is maintained by circulating hot oil, the hot oil level in the reservoir of the heating unit should be inspected frequently. If the level falls, a check should be made for leakage of the hot oil into the stored asphalt.

All storage tanks, transfer lines, pumps, and weigh buckets have heating coils or jackets to maintain the asphalt at the required temperature. Enough thermometers should be placed in the asphalt feed system to assure control of the asphalt temperature. Return lines in the storage tank should be submerged below the asphalt level in the tank to prevent the asphalt from oxidizing (Figure 3-6).



Asphalt Return Line

Figure 3-6

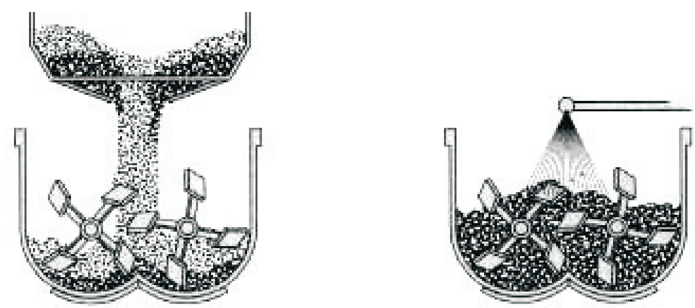
Pugmill

A twin pugmill-type mixer is commonly used in all modern asphalt concrete plants. In a batch plant this unit is mounted directly beneath the weigh box and asphalt bucket, and high enough so that it may discharge the mixture into the truck or other hauling unit.

Mixing

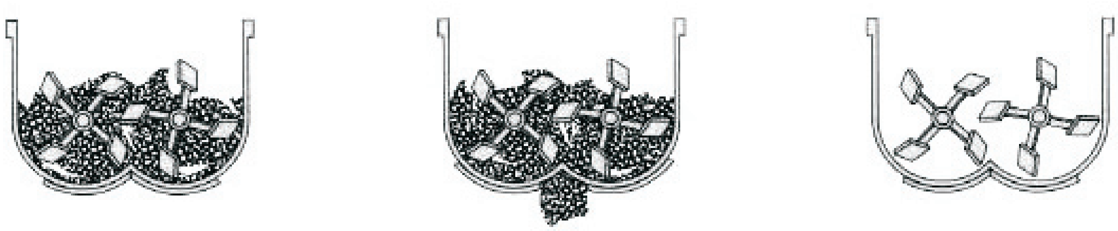
When aggregates are drawn from the hot bins as described earlier, some dry mixing takes place as the materials are deposited in the weigh hopper, as well as when deposited in the pugmill. The wet mixing time begins with the start of the flow of asphalt from the bucket or meter.

Asphalt film on the aggregate is hardened by exposure to air and heat. The mixing time should be no longer than necessary to get a uniform distribution of aggregate sizes and a uniform coating of asphalt on all aggregate particles. The engineer may require a dry mixing time of up to 15 seconds. However, the wet mixing cycle shall not be less than 20 seconds. Upon completion of the mixing time, the bottom of the pugmill mixer opens up and discharges the contents into a truck or other hauling equipment.



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

2. The asphalt is discharged into the pugmill by a spraybar.



3. The aggregates and the asphalts are mixed.

4. The pugmill gate opens and the finished product is discharged.

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

Steps in Typical Batch Plant Mixing Cycle
Figure 3-7

Particle Coating (Ross Count Procedure)

In establishing mixing times for asphalt concrete by the Ross Count Method, it is necessary first to become familiar with two definitions involved. “Dry Mixing Time” is the time between the release of the dry batch into the pugmill and the release of the asphalt into the pugmill. “Wet Mixing Time” is the time between the release of the asphalt into the pugmill and the opening of the discharge gate.

The purpose of establishing a mixing time in this manner is to permit the operation of the asphalt concrete plant with the least mixing time cycle that is consistent with the production of a mix in which: the coarse particles are completely coated; the gradation requirements are being met; and other factors are satisfied. The wet mixing time may vary from plant to plant, from mix to mix, and with the condition of the mixing equipment. This procedure for establishing mixing times permits more economical mixing operations to the benefit of the Department of Transportation and the Contractor.

A dry mixing time of up to fifteen (15) seconds may be required by the Engineer to accomplish the degree of aggregate distribution necessary to obtain complete and uniform coating of the aggregate with bitumen. The lowest mixing time possible, that will still produce a mix that meets all Department requirements, should be used. However, the wet mixing cycle shall not be less than 20 seconds. (See VDOT Road and Bridge Specifications).

Following is an outlined procedure for determining minimum mixing time by the Ross Count Method. (See AASHTO T 195) It is suggested that to start the determination of the mixing time, the plant operate on a 30 second wet mixing cycle. If the asphalt introduction requires more than 30 seconds, use this time).

- Take a sample at the plant site from three alternate truckloads.
- Sieve the sample immediately, while it is still hot, through a 3/8 in (9.5 mm) sieve (or No. 4 sieve [4.75 mm] for “SM” mixes). Take a sample large enough to yield between 200 and 500 coarse particles on the 3/8 in (9.5 mm) (or No. 4 [4.75 mm]) sieve. DO NOT OVERLOAD THE SIEVES. If necessary, sieve the sample in two or three operations. The individual sieving operations should not require more than 20 seconds of shaking manually.

Very carefully examine each particle. If even a tiny speck of uncoated stone is noted, classify the particle as “partially coated”. If completely coated, classify the particle as “completely coated”. Compute the Ross Count as below:

$$\text{Ross Count} = \frac{\text{Number of Completely Coated Particles}}{\text{Total Number of Particles}} \times 100$$

What to do with the results:

- If the average of the three samples is greater than 95% and no one sample is less than 92%, then a lower mix time can be tried. Lower time by 5 seconds.

- If the average of the three samples is less than 95% or one sample is less than 92%, then increase the mix time by 5 seconds.

Automated Plants

Modern batch plants fall into three categories, depending on the degree of automation:

(a) Manual, (b) Semi-automatic, (c) Automatic

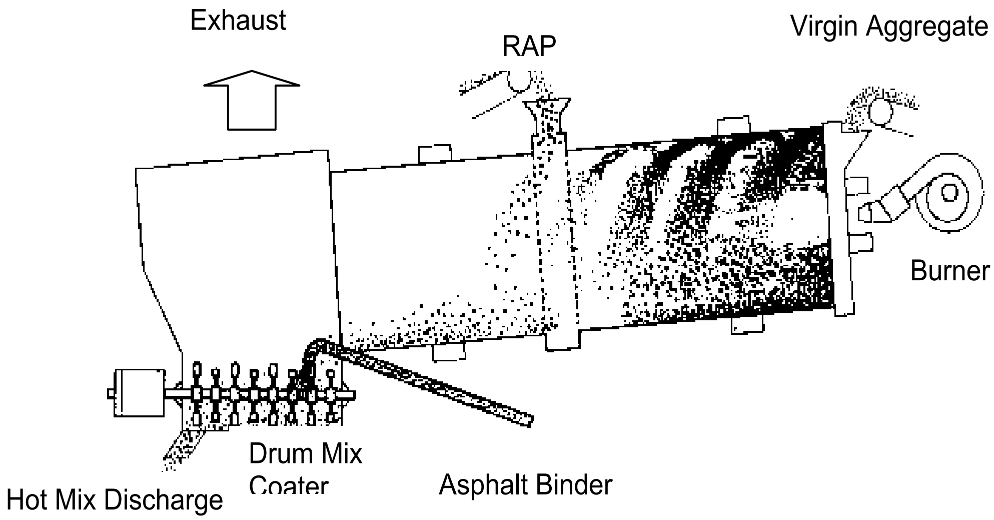
One thing most of these plants have in common is power control of the weighing and mixing process. Even in manual plants, air or hydraulic cylinders actuated by electric switches have replaced hand lever systems. They operate supply bin gates, feeders, asphalt valves, the weigh box discharge gate, and the pugmill discharge gate.

In a semi-automatic plant, all operations from the weigh box discharge to pugmill discharge are under automatic cycle control. The entire measuring and mixing phase of the plant is handled automatically. It removes the monotony and drudgery of repetitive sequence for the operator, freeing him to coordinate other plant operations, such as proper bin balancing through remote cold-feed control.

In an automatic plant, all principal components of the plant, including the aggregate scales, bitumen scales, batching controls, and mixing cycles are automatically controlled by electrical circuits, operating from preset batch weight data without manual assistance or monitoring. The definition includes plants with recordation equipment capable of printing individual batch aggregate weights, asphalt weights, and total batch mix weights. All that is accomplished by automating a plant is removal of the human error factor from the batching operation. This permits a continuous high quality mix. The input to the controls unit is either a computer program, batch plug, or preset dials containing the design weights, per batch. A dial will be preset to select the portions of a batch to fill the mixer. A mix timer is also set to regulate the mixing times.

Drum Mix Plant

Drum mixing is a relatively simple process of producing asphalt mixtures. The mixing drum looks like the familiar dryer. The difference is that the aggregate is not only dried and heated within the drum, but also mixed with the asphalt cement. (Figure 3-8.) The drum mix process depends upon cold feed control for gradation of aggregates. The drum mix plant requires the use of a surge silo for mix loadout. (Figure 3-9.) Drum mixers can produce a true hot mix or a low temperature mix.



Flow of Material Through a Drum Mixer

Figure 3-8

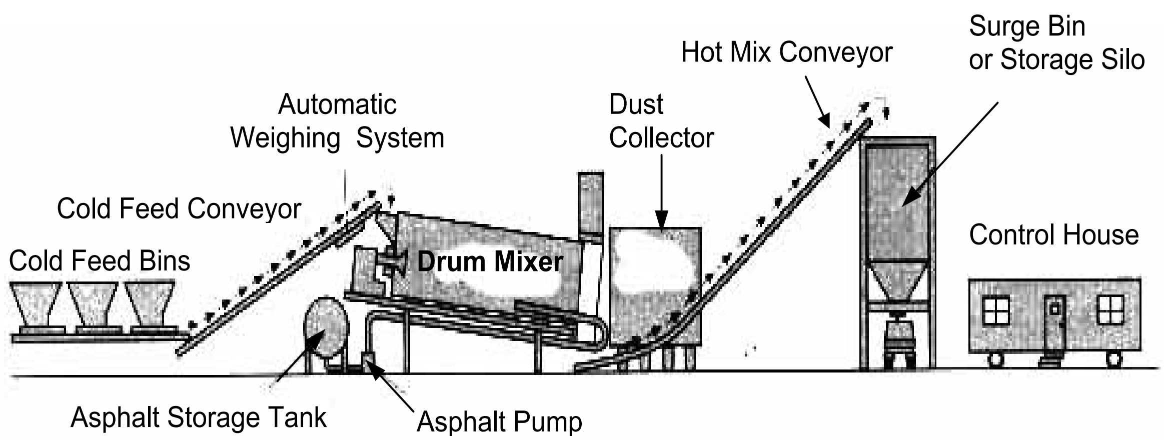
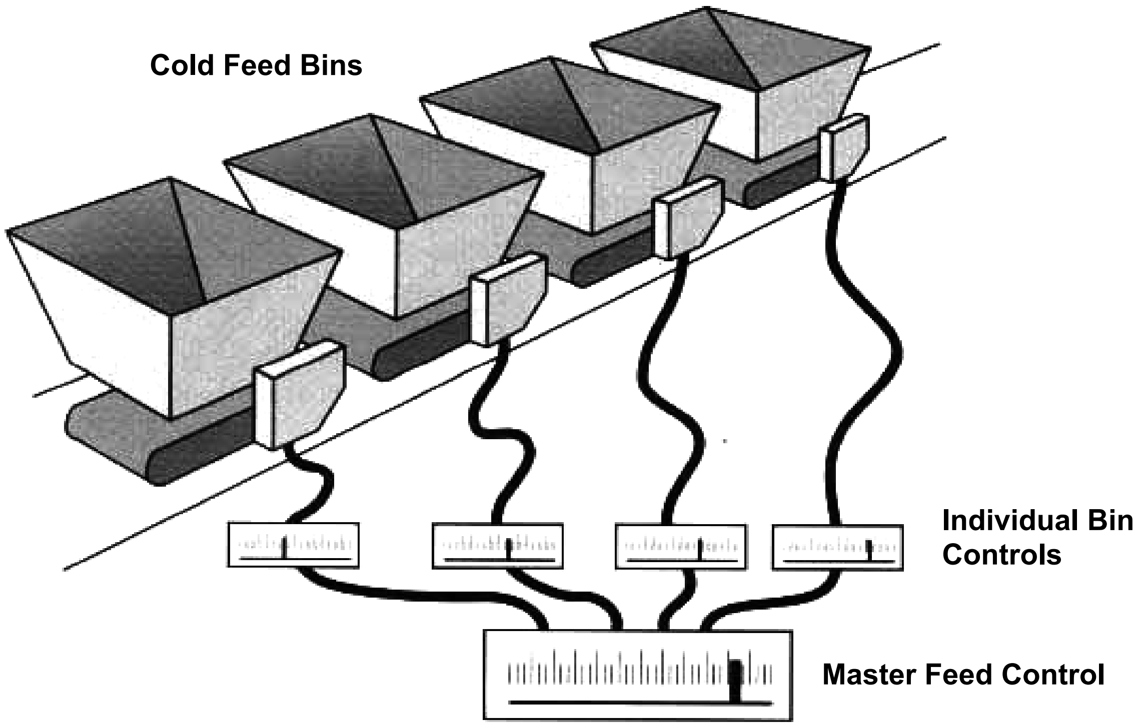


Diagram of Basic Drum Mix Plant

Figure 3-9

Production starts with the cold feed bins. It is necessary to proportion the mixing drum. Total and proportional control with variable speed belt feeders permits adjustments of individual feeder output to desired proportions. (Figure 3-10) Thus total tonnage of aggregate going to the drum mixer can be increased or decreased by the speed of the feeder belts without changing the proportions.



Cold Feed Control
Figure 3-10

At this point of production, good quality control over the aggregates is needed. The aggregates in each stockpile should be consistent as to gradation. Also, stockpiles have to be separated properly to prevent contamination of one aggregate by one of another gradation.

From the cold feed, the aggregate moves up an incline conveyor over the weigh bridge, which continually weighs the aggregate passing over the belt and indicates the flow of material over the scale at any given instant. The weight reading is the foundation of the aggregate/asphalt blending system. The asphalt metering and delivery system must be interlocked with the aggregate weigh system to assure that the precise asphalt content is achieved and maintained in the mix. Tonnage rate of aggregate going into the drum mixer, as measured by the weigh bridge, is regarded as the base figure of the total mix formula. It must be remembered that this reading reflects total mass of both aggregate and moisture.

Weight of the moisture therefore, must be subtracted to arrive at a true aggregate rate reading. Actual moisture content is determined by periodic moisture extraction test. Determining moisture content will be discussed later in this section.

From this point the aggregates go into the drum mixer at the burner end so aggregates and hot gases move through the drum in the same direction. By utilizing this principle, the hottest gases and flame exist at the charging end of the drum mixer. Thus, the asphalt is best protected from the harmful effects of oxidation and direct contact with the burner flame by the evaporating moisture on the aggregate.

While the drum mix process features a smooth continuous flow of material, inside the drum mixer certain events occur in phases within fairly well delineated zones of the drum mixer. One of the principle differences between the conventional method of mix production and drum mixing is how the aggregate is coated. Heating and mixing of the aggregates and asphalt cement is done in four phases.

Phase I - The aggregate has entered the drum mixer. In the early heating phase, surface and, free moisture begin to leave the aggregate as temperature rises.

Phase II - Most of the heat rise occurs in phase II as aggregate temperatures reach approximately 170 to 180ºF (77 to 82ºC). The majority of the moisture is driven off in this phase and the rate of increase in mixing temperature levels off.

Phase III - As mix temperature reaches between 180 and 200°F (82 and 93°C) asphalt is introduced to the mix. Moisture driven off now causes the asphalt to foam. This foaming action causes the surface area of the asphalt to be greatly enlarged, thus entrapping dust as well as larger particles and coating the aggregate rapidly. Thus, it can be seen that aggregate coating in a drum mixer is not a function of asphalt being forcibly mixed but rather of the aggregate particles being engulfed by the foaming, rapidly spreading asphalt.

Phase IV - Most of the moisture has been removed. The aggregate has been coated, and mix temperatures will continue to rise until desired temperature is reached.

After the mix temperature has been achieved, the mix is discharged into a hot incline elevator that carries the mix to either a surge silo or storage tank (Figure 3-11), where it is held at a constant temperature until used.

Surge Silos
Figure 3-11

Aggregate Moisture Determination for Drum Mix Operation

Since aggregate in a drum mix operation is weighed before drying, moisture content of the aggregate must be determined. The weighing of aggregate and the metering of asphalt cement are interlocked electronically in drum mix operations. To ensure proper metering of asphalt cement, adjustments for aggregate moisture must be made. The moisture content of the aggregate should be determined and proper allowance made for the water content, prior to mixing. Perform moisture determination prior to start of mixing and thereafter as changes occur in the condition of the aggregate.

Moisture Determination of Aggregate

To establish the moisture content of aggregate being used, it is necessary to secure a representative sample of the aggregate. When sampling, it is easier to obtain a representative sample from the production stream, such as from the conveyor belt than from storage bins or stockpiles. When taking the sample from the conveyor belt, remove it from the entire cross-section of the belt. The size of the sample taken is determined by the maximum size aggregate.

The steps for this procedure are outlined as follows:

I. Obtain a **representative sample** of the material from the production line. (conveyor belt)

2. **Reduce the sample** to a size that can be handled by the weighing device by either a sample splitter or the quartering method.

3. **Weigh aggregate** sample and record weight.(wet weight).

4. **Dry aggregate** sample thoroughly. The sample or samples are dried to constant weight on a hot plate or in an oven at a temperature of 230ºF (110ºC).

5. Accurately **weigh the dried sample** and record weight (dry weight). In weighing and handling the sample, extreme **care** must be taken to avoid any loss of the material, as this will affect the accuracy of the results.

6. **Determine Moisture Content.** The percent moisture is determined by the following formula:

$$\text{Moisture Content} = \frac{\text{Wet Weight} - \text{Dry Weight}}{\text{Dry Weight}} \times 100$$

Example -

Wet Weight of Sample = 1225 g

Dry Weight of Sample = 1175 g

$$\text{Moisture Content} = \frac{\text{Wet Weight} - \text{Dry Weight}}{\text{Dry Weight}} \times 100$$

$$\text{Moisture Content} = \frac{1225 - 1175}{1175} \times 100 = 4.3\%$$

The moisture content of an asphalt concrete mixture can also be determined. The procedure is similar to the aggregate moisture determination procedure. The steps are outlined as follows.

Moisture Determination of Asphalt Concrete Mixtures:

(1) Place mixture in pan.

(2) Weigh (both pan and mixture together) - Record the wet weight.

(3) Place in oven (set at compaction temperature) for approximately 30 minutes.

(4) Take sample from oven and weigh it - Record this weight.

(5) Place sample back in oven for approximately 15 minutes.

(6) Again, take sample from oven and weigh - Record this dry weight

(Repeat steps 5 & 6 until the sample reaches a constant weight.)

(7) After a constant weight has been established, the percent of moisture is determined by the following formula:

$$\textbf{Moisture Content} = \frac{\textbf{Wet Weight - Dry Weight}}{\textbf{Dry Weight}} \times \textbf{100}$$

NOTE: This test may be performed on aggregate blends also. The moisture content of an asphalt mixture should not exceed 1 percent.

TYPE OF TROUBLE AT THE PLANT	Extraction Fails To Check With Set-Up	Variation in Batch Color	Brown, Dead Appearing Mix	Rich, Glistening Mix	Mix Gradation Fails to Check Set-Up	Lifeless, Greasy Appearing Mix	Mix Temperature Too High	Smoking Batches	Steaming Batches	Overweight or Underweight Loads	Portion of Batches Unmixed	Variations in Batch Gradation
Faulty Extractions	X		X		X							
Over-rated Screen Capacity					X							
Too Little Oil		X	X									
Too Much Oil		X		X								
Oil Temperature Too High						X	X					
Moisture Tests Not Representative	X								X			
Improper Set on Pugmill Blades	X										X	
Slope or Speed of Dryer Drum		X					X					
Faulty Mechanical Analysis	X				X							X
Physical Characteristics of Aggregate	X		X	X								
Sampling Methods Not Uniform	X		X		X							X
Over-rated Dryer Capacity		X				X			X			
Faulty Gate Mechanism		X									X	X
Drum Feed Not Uniform						X	X	X	X			
High Soft-Absorbent Stone Content	X					X	X		X			
Excessive Moisture Content		X	X			X			X			
Aggregate Temperature Too High		X				X	X	X				
Burner Pressure Not Uniform		X				X	X	X				
Pyrometer Not Functioning Properly		X	X			X	X	X	X			
Mixing Time Not Uniform	X	X	X				X	X				
Platform Scales Out of Adjustment	X	X	X		X					X		
Oil Scales Out of Adjustment	X	X	X	X						X		
Improper Bin Division	X	X	X	X	X							X
Segregation in Bins	X	X	X	X	X							X
Segregation in Aggregate Stockpile	X	X	X	X	X							X
Return From Dust Collector Not Constant	X	X	X	X	X							X
More Than One Aperture Per Bin	X	X	X	X	X							X
Bin Overflow Pipes Not Functioning	X	X	X	X	X							X
Dust Feed Not Uniform	X	X	X	X	X					X		X
Scale Gradation Not Clearly Visible	X	X	X	X	X					X		X
Bridging of Materials in Weigh- Box	X	X	X	X	X					X		X
Batch Scales Out of Adjustment	X	X	X	X	X					X		X
Weather Conditions	X	X	X	X	X	X	X	X	X	X		X

Chart of Types of Trouble and Probable Causes
Figure 3-12

CHAPTER 3
ASPHALT CONCRETE PLANTS
Study Questions

1. The overflow chutes on a batch plant are used to:

   A. transfer material from one bin to another
   B. prevent contamination by intermingling from adjacent bins
   C. collect aggregate samples for gradation
   D. decrease production

2. The asphalt material shall be delivered into the mixer in a thin, uniform sheet or multiple streams for the full width of the mixer.

   A. True
   B. False

3. Increasing the dryer time will remove more moisture than increasing the heat.

   A. True
   B. False

4. The asphalt content for batch weight calculations is obtained from the:

   A. design range
   B. job-mix formula
   C. acceptance range
   D. none of the above

5. During the drying operation, wet aggregate will reduce the dryer's capacity.

   A. True
   B. False

6. In the drum mix plant, moisture content of aggregate must be determined before drying.

   A. True
   B. False

7. The maximum amount of mositure allowed in the completed mixture is:

   A. 10%
   B. 1%
   C. 2%
   D. 5%

Study Questions (continued)

8. What conditions effect screening efficiency?

9. What are some of the methods of controlling carry-over?

10. What is meant by proportioning of aggregates and asphalt?

11. What conditions will best insure a uniform flow of the proper aggregate sizes from the cold feed?

12. Why is proper cold feeding essential?

13. When hydrated lime is used in asphalt concrete as an antistripping additive, it shall be added at what rate?

14. What problems arise from overheating?

15. What problems arise from underheating aggregate?

16. What could cause leakage of aggregate into the weigh hopper after the desired amount has been withdrawn?

17. How often and by whom should hopper and truck scales be serviced and tested?

18. How often and by whom shall the scales used in the weighing of materials paid for on a tonnage basis be approved and sealed?

19. When using a metering device instead of a weigh bucket for proportioning asphalt to the mixer, what is one important thing that should be remembered?

20. What is the maximum dry mixing time for aggregates released into the pugmill?

21. What is the minimum wet mixing time allowed?

22. Who determines the mixing time? Who approves the mixing time?

23. Asphalt storage at the plant should be equal to at least:

    A. 1/2 day's output
    B. one day's output
    C. two day's output
    D. three day's output

Problem No. 1
Establishing the Wet Mixing Time

Given: The plant is operating on a 22 second wet mixing cycle. Two previous determinations yielded results of 94.3% and 95.1% completely coated particles. The third determination has shown that of the 230 particles there are 6 that are not completely coated.

Find:
1. The Ross Count for the third determination.
2. Does this meet the VDOT requirements for the wet mixing time?
3. What steps are taken if after conducting a Ross Count, the results do not meet VDOT requirements?

Problem No. 2
Establishing the Wet Mixing Time

Given: The plant is operating on a 21 second wet mixing cycle. Two previous determinations yielded results of 95.3% and 92.5% completely coated particles. The third determination has shown that of the 216 particles there are 14 that are not completely coated.

Find:
1. The Ross Count for the third determination.
2. Does this meet the VDOT requirements for the wet mixing time?
3. What steps are taken if after conducting a Ross Count, the results do not meet VDOT requirements?

Problem No. 3
Aggregate Moisture Determination

Determine the percent moisture in an aggregate sample that had a wet weight of 1335 grams, and after drying, a dry weight of 1290 grams. (Answer to nearest tenth of a percent.)

Problem No. 4
Aggregate Moisture Determination

Determine the percent moisture(to nearest tenth of a percent) in an aggregate sample that had a wet weight of 1275 grams, and after drying, a dry weight of 1235 grams.

Problem No. 5
Moisture Determination of an Asphalt Mixture

Given the following information, determine the percent moisture in the BM-25.0 asphalt concrete sample below.
Does this meet the VDOT Specifications?

Weight of Moist Sample = 2254
Weight of Dry Sample = 2232

Problem No. 6
Moisture Determination of an Asphalt Mixture

Given the following information, determine the percent moisture in the BM-25.0 asphalt concrete sample below.
Does this meet the VDOT Specifications?

Weight of Moist Sample = 2376
Weight of Dry Sample = 2342