4. Asphalt Plant

4.1. Introduction

Asphalt plants heat and dry the aggregate and mix it with the appropriate amount of asphalt cement, in accordance with the project mix design. There are two main types of asphalt plants: batch plants and dryer drum plants. These are briefly described below.

Standard Highway Specification 4.01-3.03 requires that the asphalt plant be calibrated as specified in AASHTO M-156. Airport Specification 401-4.2 requires the asphalt plant to conform to ASTM D 995.

The Asphalt Institute's Manuals MS-3 *Asphalt Plant Manual* and MS-22 *Principles of Construction of Hot-Mix Asphalt Pavements* contain much more information on asphalt plants.

Batch Plants

Batch plants make asphalt concrete one batch at a time. This is done by placing measured amounts of different-sized aggregate and asphalt cement in a "pugmill," where they are mixed. The pugmill is then emptied and the process repeated. The aggregate and asphalt cement are heated before they are placed in the pugmill. The process is shown in the diagram on the page 4-4.

Aggregate at the plant starts at the *cold bins* (see Figure 4-1). There are usually three or four bins for different sizes of aggregate. The aggregate empties through the bottom of the bins through feeders (most operate with a small belt or a vibrator). The feeders are equipped with adjustable *cold feed gates*. Aggregate in different bins is released at different rates to form the proportional combination of material for the mix design. The correct proportions are obtained by calibrating the gates and adjusting the variable speed feeder belt. Aggregate from all the feeders is deposited on a main cold feed conveyor.

The *cold elevator* carries the proportioned aggregate from the conveyor to the *dryer*, which heats and dries it. The dryer consists of a revolving cylinder, a large burner, and a fan. The revolving cylinder is lined with long vanes called “flights,” which spread the aggregate into a veil to ensure proper drying. The burner is located at the lower end of the dryer, so while the aggregate is moving down, the hot gases are moving up. This is known as “counter flow.”

The exhaust gases from the dryer contain dust that is removed in the baghouse or wet scrubber before the hot gases are released into the atmosphere. These emissions are regularly tested. A permit issued by the State of Alaska Department of Environmental Conservation is posted at the plant. The fines, called mineral filler, are recycled into the hot aggregate or are imported for mineral filler.

The *hot elevator* carries the aggregate from the dryer to a *screening unit.*

Motors shake a set of screens, which sort the heated aggregate by size and deposit it into a new set of aggregate bins, the *hot bins*.

Below the hot bins is the *weigh box*. The weigh box is filled and weighed successively with aggregate from each of the hot bins (see Figure 4-3). If mineral filler is used, it is taken from the *mineral filler storage* and also measured into the weigh box at this time.

The amounts are controlled to produce a batch of aggregate with the correct size, which is then released into the *pugmill*. The aggregate is “dry mixed” briefly before the asphalt cement is added.

The asphalt is continuously circulated from *hot asphalt cement storage* tanks through a piping system. Both tanks and the piping are heated. Asphalt cement can be drawn from the piping into the *asphalt weigh bucket*, which measures the amount needed for a batch of paving mix.

Once asphalt cement from the weigh bucket is added to the pugmill, the batch is “wet mixed” just long enough to coat the aggregate with asphalt. The mix is then discharged into trucks either directly or after temporary storage in a “surge silo.”

4.2. Dryer Drum-Mix Plants

Dryer drum-mix plants combine and heat aggregate and asphalt cement continuously. Measured amounts of different sized aggregate are fed into the upper end of the dryer. The asphalt cement is added near the middle of the dryer. The asphalt cement is added near the middle of the dryer, where it mixes with aggregate, which has already been heated and dried. The process is shown in Figure 4-5.

The aggregate at a drum dryer plant starts at a set of *cold bins*, just like at a batch plant. The gates on the bin feeders are calibrated and adjusted to release the correct proportions of the different sized aggregate onto the *cold feed conveyor*.

The conveyor has an *automatic weighing system*, which includes a belt speed indicator. The weighing system is interlocked with the *asphalt pump* so that (when properly calibrated) the correct amount of liquid asphalt is added to the aggregate in the dryer. Since the asphalt must be delivered in proportion to the *dry* weight of aggregate, the metering system must be adjusted to account for the moisture content of the aggregate. The *hot asphalt storage* tanks and circulation system are similar to those for batch plants.

The *drum mixer* consists of a revolving cylinder lined with flights, a large burner, and a fan, like a batch plant dryer. Unlike batch plant dryers, asphalt cement can be added within the dryer, where it mixes with the aggregate. The asphalt is added roughly halfway down the length of the drum. This is known as “parallel flow.” The flame in a drum dryer should be short and “bushy.” Parallel flow and a short flame are used so that the gases are cool enough by the time they reach the lower end of the drum that they will not burn the asphalt.

In dryer drum-mix plants, the burner is at the upper end of dryer, so both the aggregate and the hot gases move downward through the drum.

As with batch plants, gases leaving the drum pass through a *dust collector* and exhaust stack, and some of the fines from the dust collector may be recycled back into the mix.

The paving mix leaves the drum and is carried by a *hot mix conveyor* to the *mix surge silo*, from which it is discharged into trucks.

Dryer drum plants do not have screens, hot bins, a weigh box, an asphalt weigh bucket, or a pugmill.

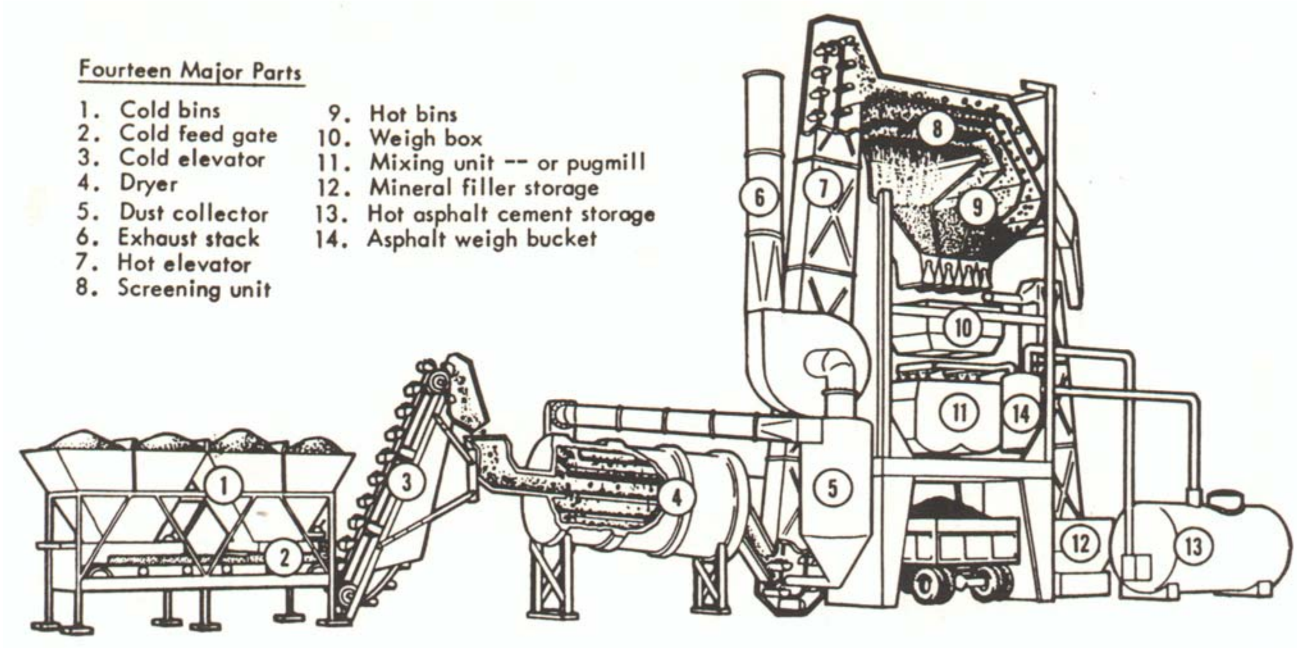

Figure 4-1
Asphalt Batch Mix Plant and its Components (modern plants also include a baghouse in addition to the dust collector shown as 5 above and the cold elevator (3) has been replaced by conveyors). Courtesy of The Asphalt Institute

Figure 4-2
Asphalt Batch Plant

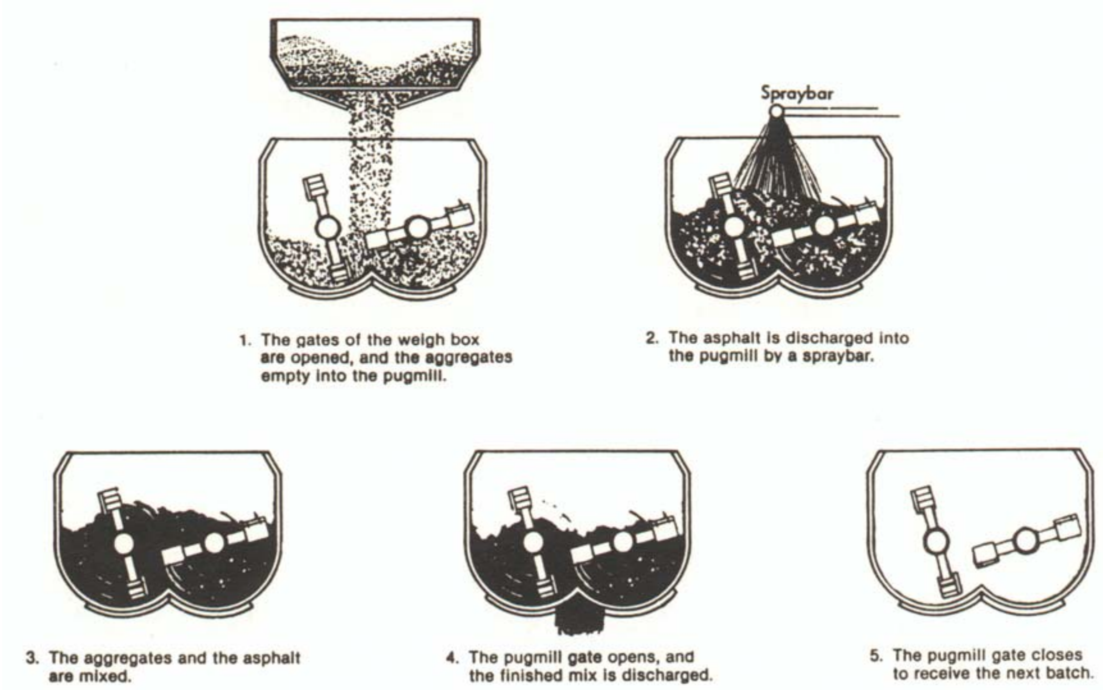

Figure 4-3
Weigh Box Operation
Courtesy of the Tennessee Department of Transportation

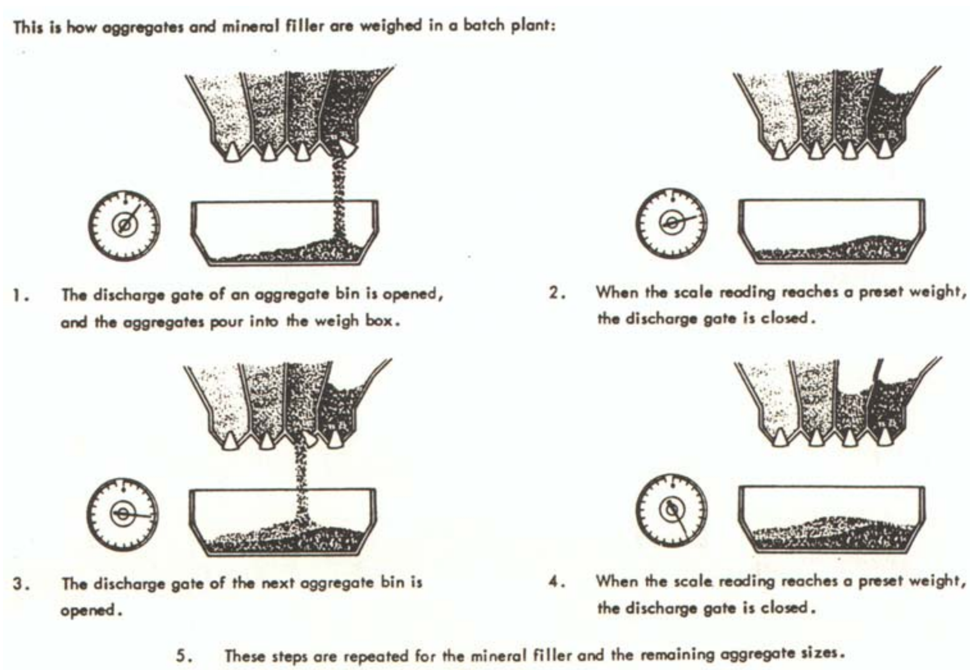

Figure 4-4
Pugmill Operations
Courtesy of The Asphalt Institute

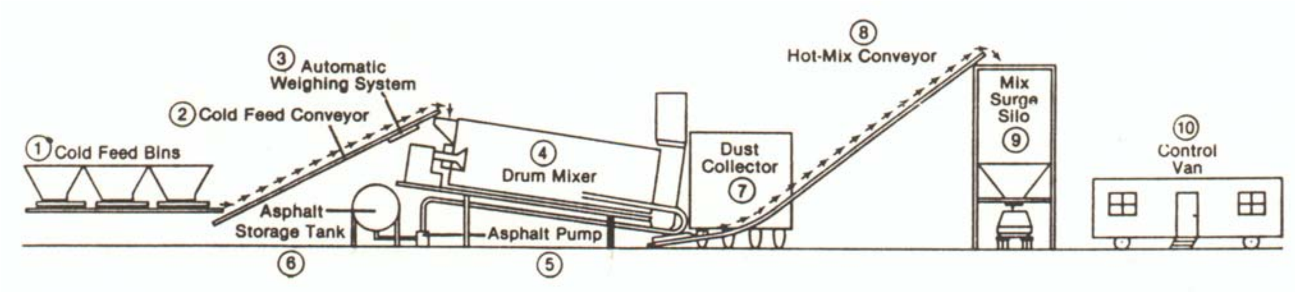

Figure 4-5
Basic Drum-Mix Plant
Courtesy of The Asphalt Institute

4.3. Proper Plant Operation

4.3.1 General

The best and most consistent asphalt concrete will result when it is produced steadily at the rate needed by the paving operation. Startups and shutdowns, as well as constant tinkering with gate openings and other controls, are signs of a poor operation. Major adjustments should be made *before* a production run; only fine-tuning should be needed during the run.

The entire plant must be brought up to operating temperature before the start of a production run. Running "dry" aggregate (no asphalt) through the plant does this. The "dry run" aggregate may be checked for moisture, which avoids wasting out-of-spec "wet" paving mix. In continuous mix plants, when no asphalt is added, a check of the aggregate gradation at the end of the process may be done. Running dry aggregate results in heavy dust emissions, so most operators add a small amount of asphalt to avoid violating their environmental permits.

4.3.2 Stockpiling

A good mix will not come out of a plant if the aggregates going into it are bad. Many problems in mix production can be traced back to the cold aggregate. Even if good material comes out of the crusher, bad material will go into the cold bins if aggregate becomes contaminated or segregated during stockpiling or cold bin loading. Proper stockpiling is discussed in Section 4.2.

4.3.3 Cold Bins

The gates on cold bins should be calibrated to determine how much material they release at different settings. Proper operation of the cold feed is crucial to the entire plant operation and depends on the gate settings. Calibration charts, rather than trial-and-error methods, should guide any adjustments to the gates. Gate adjustments should seldom be needed during production. Frequent adjustments may indicate improper initial setup or variation in the aggregates due to crushing or stockpiling problems.

The level of material in each bin should be maintained so that there is no danger of them running out. Overfilling or careless loading, however, can result in one aggregate size spilling over into a bin for another.

Cold bins need to be watched to ensure material is flowing smoothly from the gates. Aggregate, especially sand sizes, can plug up or "arch over" in the bins.

4.3.4 Cold Feed

Varying the feeder belt (or vibrator) speed controls the amount of aggregate fed into the plant, not bin gate openings. The gates should be preset so that during normal operation the belts run at 50 to 80 percent of their maximum speed.

Feeder belt (or vibrator) speeds are usually adjusted to match plant production with the demand from the mix (that is, the rate of paving). Cold feed adjustments must be coordinated with burner adjustments on the dryer. For a given burner setting, a slower feed rate results in a higher output temperature, and vice versa. Watch for loss of calibration due to spillage or drag caused by misalignment of the feeder belt.

Figure 4-6
Asphalt Cement Storage Tanks

On a drum dryer plant, the weighing system and belt speed on the main cold feed conveyor control the asphalt feed rate. It is important to check the belt speed indicator for slippage, especially when a plant first starts a production run. Watch for loss of calibration due to belt tension errors caused by buildup of aggregate at the tail roller, misalignment of the belt, and frozen rollers. Also watch for friction or obstruction of the load cell mechanism.

4.3.5 Asphalt Cement Storage

Most plants have at least two tanks, which must be level for tank stick measurements to be accurate. Both the tanks and the circulation system piping must be heated.

Asphalt oxidizes quickly at high temperatures, so exposure to air needs to be minimized. For this reason the circulation return line must discharge below the surface of the asphalt in the tank.

Keeping the storage temperature below the specified maximum (usually about 325°F) minimizes oxidation and the danger of explosion. Temperature corrections must be made to tank measurements; asphalt expands with rising temperatures. Correction multipliers listed in Appendix B convert measured quantities to the standard 60°F basis. Temperature correction is also needed when calibrating asphalt pumps in dryer drum plants.

Carefully document asphalt deliveries.

4.3.6 Batch Plant Dryer

The temperature of the aggregate leaving the dryer is affected by the feed rate, the time the aggregate stays in the dryer, and the burner setting. Residence time in the dryer is usually three to four minutes. Dryers are usually tilted about 3 to 5 degrees from horizontal; the steeper the tilt, the faster the aggregate passes through.

For even, efficient heating, the dryer should spread the aggregate in an even veil across the center of the drum. This is affected by the arrangement of the flights and the speed of the drum (usually about 8 to 10 rpm).

Burner and draft fan adjustments are also important to dryer operation. In an efficient dryer there is complete combustion of the fuel and the exhaust gases leave the drum about 20 degrees hotter than the aggregate. Incomplete fuel combustion is indicated by oily residue on the aggregate and/or black, oily exhaust. This is bad for the mix and increases air pollution and fuel costs.

The production rate of the entire plant is dependent upon the dryer's efficiency. Asphalt concrete can't be produced any faster than the aggregate can be heated and dried.

4.3.7 Drum-Mixer Dryer

The information about batch plant dryers also applies to drum-mixer dryers. An exception is that exhaust gases in drum mixers are much hotter than the mix produced, due to the lower efficiency of the parallel flow system. Residence time in the dryer of a drum-mix plant is very important since it is also the mixer. If residence time is too short, the aggregate may not be completely coated with the asphalt. Over-mixing, on the other hand, leads to oxidization (premature aging and embrittlement) of the asphalt cement.

4.3.8 Dust Collector

Good operation of the dust collection system not only reduces air pollution but also helps produce a good mix.

The pressure drop in a baghouse is typically 2 to 6 inches of water. If the bags become plugged, the pressure drop increases and the draft will be retarded. This results in poor fuel combustion and a bad paving mix.

If fines from the dust collector are recycled back into the mix, the feed must operate smoothly. If the flow of fines is uneven, the plant will produce a bad mix, with alternately too many and too few fines.

4.3.9 Hot Mix Storage and Loading

Hot mix conveyors should have scrapers to prevent carryover (belt drippings).

Segregation is the biggest problem in storage and loading. It can be minimized during silo loading by baffles or batching mechanisms. Trucks should be loaded by dumping the mix in a series of overlapping heaps. Dribbling or flinging the mix when loading either silos or trucks leads to segregation and should be avoided.

(The remaining items of Section 4.3 apply only to batch plants)

Segregation in a silo is more likely if it is completely emptied several times during a shift. Use of a strain gauge bin level indicator is desirable since most high/low bin indicators are unreliable. It is desirable to keep the silo one-third to two-thirds full. Cooling is a problem if the mix is held too long in a silo, especially if the amount of mix is small or the silo is not insulated.

4.3.10 Screening Unit

Proper, consistent aggregate in a batch plant depends on the hot screening operation. Motors and bearing must be in good condition to ensure adequate screen speed. Worn screens develop holes, which allow oversize aggregate to fall into the bins for smaller material.

The opposite problem can also occur. Aggregate must stay on the finer screens long enough for the small material to pass through them. An excessive feed rate results in "carryover" of smaller particles into the coarse aggregate bins. Carryover may result if the screens are plugged.

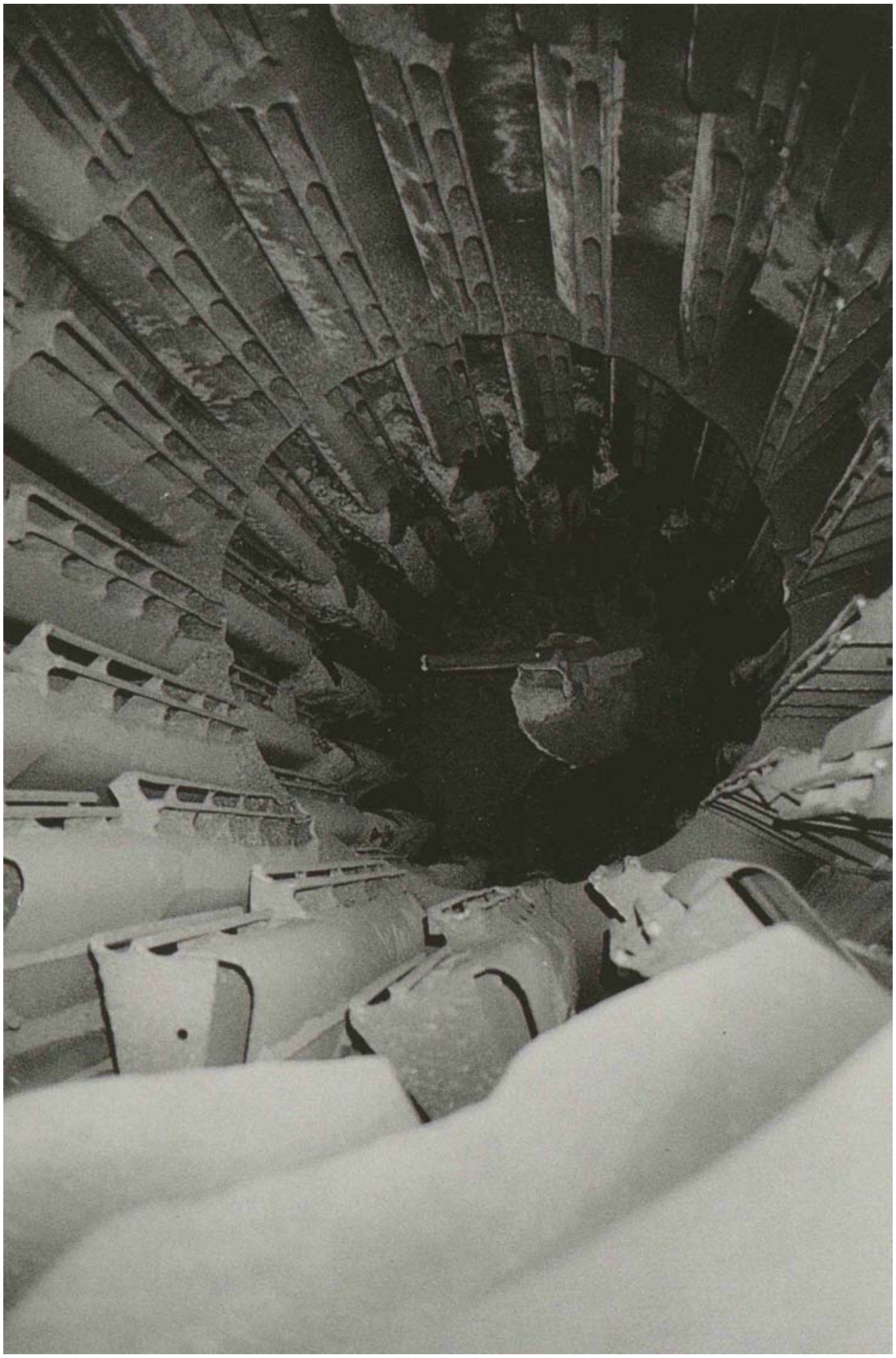

Figure 4-7
Flights in a Drum-Mix Dryer

Figure 4-8
Hot Asphalt Storage Silos

4.3.11 Hot Bins

Temperature control is best when production is steady and material is not allowed to stay in the hot bins too long. Bin gates must not leak when closed.

Bins should have telltales to warn if a bin is nearly empty and automatic cutoffs to stop batching if a bin is completely empty. The plant must continue to operate to refill the empty bin.

Overflow pipes on hot bins must be kept clear to prevent material from one bin from spilling into the next, which results in an improper gradation mix. Overflow usually indicates improper gradation of the aggregate entering the plant, i.e. a problem with the crusher, the stockpiling, the cold feed bin loading, or gate settings. It may also result from problems with the hot screening unit (worn screens or carryover).

4.3.12 Weigh Box

The scales operate in a dusty environment, so the accuracy and cleanliness of the system should be checked daily. Scales may become inaccurate if fulcrums, knife edges, or other parts become dirty or if moving parts bind against each other. A weight indicator (dial or beam), which does not move freely or go to zero at no-load needs immediate attention. Weigh box gates should not leak when closed.

4.3.13 Asphalt Weigh Bucket

Asphalt scales and meters need to be checked and calibrated for accuracy. Asphalt and dust may build up on or in the bucket, so its empty (tare) weight must be checked often. Cutoff valves must not allow excess asphalt to drip into a pugmill batch.

4.3.14 Pugmill

Mix time should be the minimum needed to adequately coat the aggregate with asphalt, as determined by Ross Count tests. Over mixing leads to oxidation (premature aging and embrittlement) of the asphalt.

Excessive clearance between paddle tips and the pugmill liner result in “dead spots” of unmixed material in the mixer. Paddles wear with time, so the clearance needs periodic adjustment to stay within specifications. The clearance between paddle tips and pugmill is generally 3/8 inch to 5/8 inch.

Nonuniform mixing will result if the mixer is filled higher than the reach of the paddles or, conversely, if there is very little material in the batch. This is avoided by following the manufacturer’s recommended batch sizes.