Chapter 3

Equipment Used in Bituminous Operations

Properly maintaining the equipment is a basic principle of bituminous operations, and it is an important function of the operator and the maintenance crew. Much of the equipment used in bituminous operations is costly and complex. The lack of proper lubrication, adjustments, and other maintenance procedures results in lost time, costly repairs, and premature replacements. In addition, improper care can adversely affect mission accomplishment.

SECTION I - PRODUCTION EQUIPMENT

ASPHALT PLANT

3-1. The objective of an asphalt plant is to produce a mixture properly coated with asphalt that consistently meets the requirements specified in the JMF for aggregate gradation, asphalt content, and temperature. Control of the mixture quality must be initiated at the stockpiles. Each nominal aggregate size should be stockpiled so that no mixing with other aggregate stockpiles nor segregation within the stockpile occurs. The stockpiled material is normally fed into the aggregate hopper with a front-end loader. A separate hopper is provided for each aggregate to be fed into the mixture.

BATCH AND CONTINUOUS-MIX PLANTS

3-2. Batch and continuous-mix plants are shown in Figures 3-1 and 3-2, page 3-2. Cold-feed hoppers have individual feeders for each of the aggregates to be used in the mixture. These feeders must be set so that the desired percentage of each aggregate is fed into the plant. The rate of feed may be controlled by the gate opening, the belt speed, or other methods depending on the type of cold feed. If the aggregate feeders are improperly set, the following problems may occur:

- An aggregate hot bin will overflow with material while another hot bin runs low on material.
- The gradation of the aggregate in the mix being produced will not meet the design gradation.
- The amount of natural sand may vary from the design proportion and may exceed the amount allowed in the specifications.
COLD-FEED CALIBRATION

3-3. Before starting a project, calibrate the cold feeds so that each feeder can feed the desired rate of material. The cold-feed calibration involves feeding one aggregate at a time onto a belt that is common to all aggregates. The belt speed should be determined before calibrating the feeders. One way to do this is to divide the belt length by the time required for one revolution. After the material is fed onto the belt, the material over a given length (for example, 5
feet) should be completely removed and weighed. The following formula can be used to convert the weight of the sample taken to tons per hour:

\[ R = \frac{1.8WS}{L} \]

where—

- \( R \) = rate of feed, tons per hour
- \( W \) = weight of sample, pounds
- \( S \) = speed of belt, feet per second
- \( L \) = length of belt sampled, feet

3-4. Each aggregate should be fed at four or five different feeder settings and the rate of feed determined. A plot of this data showing the relationship between the rate of feed (tons per hour) and the feeder setting (gate opening, feeder belt speed, or any other method for setting the aggregate feeder) should be prepared for each aggregate. These plots can be used to set each feeder at the desired rate.

**DRYER**

3-5. After the aggregate feeders have been properly set, the aggregate is carried up the cold elevator and through the dryer. The dryer removes the moisture from the aggregate and heats the aggregate to the desired temperature.

**DUST COLLECTOR**

3-6. A dust collector collects the dust created in the dryer and other plant components and adds part or all of it back into the mix at the hot elevator. Many mixes have an excessive amount of dust, and the excess should be removed. The plant should have the capability to remove any desired portion of the collected dust from the mixture.

**SCREENING**

3-7. The aggregate exits the dryer and is carried with the returned dust up the hot elevator, over the screening deck, and into the hot bins. Screen sizes are selected so that oversize material is rejected and remaining aggregates are separated into various sizes. Ideally, the screen sizes should be selected so that the amount of material going into each hot bin is proportional to the relative volume of that hot bin. For example, suppose that the first hot bin has a volume of 100 cubic feet, the second hot bin has a volume of 50 cubic feet, and the third hot bin has a volume of 50 cubic feet. Screens should be selected so that 50 percent of the material will go into the first bin, 25 percent into the second bin, and 25 percent into the third bin.

**PERCENTAGE OF EACH HOT BIN**

3-8. Determine the percentage of each hot bin to be used in the mixture. To do this, properly set the cold feeds and run the material into the hot bins. Take samples of each hot bin and determine the gradation for each sample. The percentage of each bin to be used should be selected so that the gradation of the combined materials from the hot bin is equal to the JMF.
MIXING AGGREGATE AND ASPHALT

3-9. After the cold feeds and hot bins are properly set, mix the combined aggregate from the hot bins with the proper amount of asphalt. The mixing time, generally 5 seconds for dry mixing and 25 to 40 seconds for wet mixing, should be selected so that all aggregate is coated. The plant should now be set to produce a uniform asphalt concrete mixture that has proper aggregate gradation, asphalt content, and temperature. The aggregate feeders, cold elevators, dryers, dust collectors, hot elevators, screening decks, and hot bins are similar for batch and continuous-mix plants. Batch and continuous-mix plants differ in the proportioning and mixing of the asphalt mixture:

- **Batch plant.** A batch plant weighs the various nominal size aggregates and asphalt to produce a batch of material that is then mixed for a specified period of time.

- **Continuous-mix plant.** A continuous-mix plant adds aggregate and asphalt to the mixer while the final product exits the mixer. For a continuous-mix plant, the hot-bin feeder and the asphalt feeder must be calibrated to ensure that the correct proportions of each are added to the mixture. The mixing time is computed by dividing the mixer capacity by the material’s rate of feed into the mixer.

DRUM MIXER

3-10. An asphalt plant that has become popular throughout the paving industry is a drum mixer (Figure 3-3). A drum mixer is less expensive than a batch plant and generally produces material at a higher production rate. When a drum mixer is used, the gradation must be controlled at the cold feed because no additional screening of the mixture occurs. The drum mixer is frequently used in the production of recycled asphalt concrete as well as conventional asphalt concrete.

![Figure 3-3. Drum Mixer](image-url)
COLD-FEED CALIBRATION

3-11. The cold feed is set up much the same way as a batch plant, but a drum mixer has a weight sensor on the aggregate-feed belt that weighs a given length of the loaded belt. To calibrate cold feeds, each aggregate can be fed onto the belt at various gate openings or individual belt speeds, weighed, and the feed rate computed. These steps should be followed for each of the aggregates to be added to the mixture, and a calibration curve should be developed. A meter is used to measure and control the rate that asphalt is added to the mixture.

DRYER

3-12. The burner for the dryer on a drum mixer is located on the high side of the drum. Aggregate enters the dryer just below the burner and helps shield the asphalt binder from direct contact with the flame. Asphalt is added to the dryer at approximately midpoint to two-thirds the length to prevent close contact with the flame, which could cause overheating and damage the asphalt binder.

STORAGE SILO

3-13. A storage silo is often used to store a bituminous mixture before it is loaded onto trucks. Thus, plants can run continuously even when there is a temporary shortage of trucks. Material can be stored in silos for short periods of time; but if it is stored too long, the material may oxidize excessively and cause the bituminous binder to become hard and brittle. There are many types of storage silos, with some doing less damage than others to the asphalt concrete. As a general rule, bituminous concrete mixtures should be stored no more than 4 hours regardless of the type of storage silo used. If segregation of aggregate or drainage of bitumen occurs in the silo, use of the silo should be disallowed or changes should be made to prevent segregation and drainage.

TRAVEL PLANT

3-14. A travel plant is often used to produce cold mix in place. It does not provide control of materials or mixing as well as a central plant. Aggregate is fed to a travel plant, and the proper amount of asphalt binder is continuously mixed with the aggregate. The bituminous mixture is placed to the desired grade and compacted. The aggregate to be mixed is normally windrowed before being picked up and mixed with a travel plant.

LIQUID HANDLING EQUIPMENT

3-15. Some of the equipment used to handle liquids for paving operations are listed below:

- Oil heater. It is used to heat bitumen during asphalt operations and is also used during dedrumming operations.
- Asphalt melter. It is a skid-mounted, dedrumming melter and consists of a dedrumming tunnel that is capable of removing 85- to 100-penetration AC from 8 to 12 55-gallon drums at once. It contains a
3,000-gallon storage compartment for heating asphalt to pumping temperatures. The heated asphalt can be transferred with a standard asphalt pump to storage tanks or bituminous distributors. An asphalt melter is equipped with heat-dissipating coils in the tunnel and storage compartments, and an oil heater is used as an external heat supply.

- **Asphalt kettle.** It has a 165-gallon capacity and is primarily used in maintenance work. For more information, see TM 5-3895-364-14.
- **Storage tank.** It is a 5,000-gallon, horizontal, trailer-mounted, steel tank that provides bulk storage of bituminous materials. Heating coils running throughout the tank allow hot-oil heat to be applied to the asphalt. A storage tank cannot be used to transport materials because the trailer is designed to carry only an empty storage tank.
- **Truck-mounted distributor.** It has a 1,500-gallon capacity and can be used as a pump or a transporting device.

**HAULING EQUIPMENT**

3-16. A 20-ton dump truck is the standard equipment used to haul aggregates and plant mix. A by-product or diesel fuel is often used to coat the truck bed before loading to facilitate cleaning; however, using diesel fuel may contribute to environmental or fire hazards.

**SUPPORT EQUIPMENT**

3-17. Aggregate handling equipment may include a clam shell, a belt conveyor, a front loader, or a dozer depending on a plant’s location and the type of cold-aggregate feeder used. A low-bed trailer, a truck-mounted crane with a barrel sling, and an air compressor with a drum-opening tool are needed to transport, store, and open drums of AC. Fuel trucks are required to supply fuel for oil heaters and power plants.

**SECTION II - PLACEMENT EQUIPMENT**

**TRUCK-MOUNTED ASPHALT DISTRIBUTOR**

3-18. A truck-mounted asphalt distributor (Figure 3-4) sprays bituminous material onto a prepared surface. It has the following characteristics:

- A 1,500-gallon insulated tank is equipped with heating flues to apply heat from an oil burner.
- A hydraulic pump provides power for the hydraulic motor, the bitumen pump, the fuel pump, and the air blower.
- An asphalt or bitumen pump has a delivery capacity of 400 gallons per minute (GPM).
- Bituminous material is applied through an adjustable spray bar or a hand-operated spray gun.
- Quadrant control levers and hand-operated valves control the flow of bituminous material.
- A tachometer registers the pump's discharge in GPM.
- A bitumeter shows the forward speed of the truck in feet per minute.

Figure 3-4. Truck-Mounted Asphalt Distributor
3-19. Table 3-1 shows the necessary bitometer and tachometer readings for given nozzle sizes to obtain the desired rate of bitumen application. For more information on a truck-mounted asphalt distributor, see TM 5-3895-371-10.

Table 3-1. Bitumen Application Rates

<table>
<thead>
<tr>
<th>Gallons per Square Yard</th>
<th>Nozzle Size</th>
<th>Bitumen Counter Reading</th>
<th>Pump Rate of Flow Indicator Readings in GPM</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.10</td>
<td>1/8</td>
<td>900</td>
<td>80</td>
</tr>
<tr>
<td>0.20</td>
<td>1/8</td>
<td>450</td>
<td>80</td>
</tr>
<tr>
<td>0.25</td>
<td>1/8</td>
<td>360</td>
<td>80</td>
</tr>
<tr>
<td>0.30</td>
<td>1/8</td>
<td>300</td>
<td>80</td>
</tr>
<tr>
<td>0.40</td>
<td>1/8</td>
<td>225</td>
<td>80</td>
</tr>
<tr>
<td>0.50</td>
<td>1/8</td>
<td>180</td>
<td>80</td>
</tr>
<tr>
<td>0.60</td>
<td>1/8</td>
<td>150</td>
<td>80</td>
</tr>
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<td>82</td>
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<td>135</td>
<td>90</td>
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<tr>
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<td>1/8</td>
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<td>108</td>
</tr>
<tr>
<td>1.00</td>
<td>1/8</td>
<td>135</td>
<td>120</td>
</tr>
</tbody>
</table>

TRAILER-MOUNTED (TANKLESS) ASPHALT DISTRIBUTOR

3-20. A trailer-mounted asphalt distributor (Figure 3-5) is used as a stationary pump to transfer liquid bitumen from an asphalt melter to the storage tanks in a dedrumming setup. It can also be equipped with a spray bar, towed along the project, supplied with an outside source of asphalt, and used to apply asphalt at a uniform rate over a surface. For more information on a trailer-mounted asphalt distributor, see TM 5-3895-364-14.

ASPHALT FINISHER

3-21. The model 780T asphalt finisher (Figure 3-6) is used to lay hot and cold bituminous mixtures into a smooth mat. The mat width varies from 6 feet (using bolt-on cutoff shoes) to 16 feet (with bolt-on screed and auger extensions). The model 780T can pave a maximum depth of 8 inches at a maximum speed of 135 feet per minute. It has a moveable control console that provides the operator with fingertip command of the machine's functions. An asphalt finisher moves outward from the conveyors and distributes the mixture evenly to the screed.
Figure 3-5. Trailer-Mounted Asphalt Distributor

Figure 3-6. Model 780T Asphalt Finisher
3-22. Reversing the direction of the conveyors empties the hopper toward the front of the paving machine. The weight and vibration of the main screed provide initial compaction of the mat. The screed is equipped with four hydraulic vibrators to provide initial compaction, and the main and extension screeds are equipped with burner/blower pairs. Each pair operates together to increase the temperature of the screed plates to 300°F. Mat thickness is controlled by adjusting two screws or the tow-point movement switch (hydraulic cylinders). The screed can be adjusted to produce a crowned mat, and the finisher is powered by a diesel engine. See TM 5-3895-373-10 for further information on the model 780T asphalt finisher.

COMPACTORS

3-23. A number of roller types are being used for paving operations. Rollers used to compact bituminous mixtures are static steel-wheel, vibratory steel-wheel, and rubber-tired rollers. Rollers should normally be operated 3 to 5 miles per hour (mph) (fast walking speed). Do not make quick turns on freshly laid mixtures.

STATIC STEEL-WHEEL ROLLERS

3-24. There are three versions of static steel-wheel rollers—two-wheel tandem, three-wheel tandem, and three-wheel tricycle. Static steel-wheel rollers (Figure 3-7) are generally used for breakdown and finish rolling. They leave a smooth finish on the pavement surface, but excessive rolling may result in lateral movement of the mixture causing surface cracks and density loss. They should be equipped with a system for watering the drums and should have scrapers to remove any material that sticks to the drums.

Figure 3-7. Static or Vibratory Roller
VIBRATORY STEEL-WHEEL ROLLERS

3-25. Vibratory steel-wheel rollers are commonly used to compact bituminous mixtures. They may consist of dual-drum vibration, single-drum vibration, and single-drum static or single-drum vibration and rubber tires on the rear axle. Vibratory steel-wheel rollers can be used for breakdown, intermediate, and finish rolling. Breakdown and intermediate rolling are performed in the vibratory mode, and finish rolling is performed in the static mode. Although a vibratory roller is used for intermediate rolling, it does not replace a rubber-tired roller. A vibratory roller should have a watering system on steel drums and rubber tires (if applicable) along with scrapers on the steel drums and scrapers and pads on the rubber tires.

RUBBER-TIRED ROLLERS

3-26. Rubber-tired rollers (Figure 3-8) are used for intermediate rolling of bituminous mixtures. They increase compaction after breakdown rolling and produce a watertight surface. A large rubber-tired roller (maximum load is 4,500 pounds per tire and minimum tire inflation pressure is 90 psi) should be available for construction of heavy-duty pavements on roads or airfields. A rubber-tired roller should have a watering system for the tires and should have scrapers and pads to prevent accumulation of materials on the tires. A large rubber-tired roller should be used to compact all heavy-duty bituminous concrete pavements.

Figure 3-8. Pneumatic, 9-Tire Roller
OTHER COMPACTION DEVICES

3-27. Expedient hand tampers can be constructed to compact patches and small, inaccessible areas. Vibratory and combination rollers are generally used on civilian projects.

MOTOR GRADER

3-28. A motor grader (Figure 3-9) has many uses in road and airfield construction. It can be used to spread cold plant mixes and road mixes in lieu of an asphalt finisher; but controlling a grader is difficult, so hand-raking may be necessary. A grader can be used to windrow, mix, and spread road mixes with acceptable results. A grader is the best type of equipment for manipulating and air-drying road mixes. See FM 5-434 for further information on motor graders.

HAND TOOLS

3-29. The following hand tools are commonly used in paving operations:

- **Rakes and shovels.** They are used to spread bituminous mixes in patch areas and small, inaccessible areas; control material flow into the paver hopper; and correct small surface irregularities. Heat rakes and shovels before using them, and clean them immediately after use.

- **Wooden blocks.** They hold up the floating screed at the beginning of a paving operation until it moves far enough forward to be supported by the mix (Figure 3-10).

- **Straightedges.** They are long, rigid devices used to check surface irregularities (Figure 3-11). Commercial varieties are metal and 10 to 16 feet long; expedient models are made of wood. Good results can be achieved from two straight, 10- to 16-foot, 2- by 4-inch boards nailed or bolted together with a thin spacer in between. Although an expedient straightedge is bulky, do not use smaller boards because they do not provide enough rigidity. Overlapping straightedge checks by at least 50 percent eliminates false readings.
Figure 3-10. Blocks Supporting a Paving Screed

Figure 3-11. Using a Straightedge

Method of overlapping

False Reading

True reading
3-30. Tools are commonly cleaned by burning off the bitumen. Be very careful when cleaning tools in this manner because the flames are not always visible. Always ensure that a proper fire extinguisher is readily available.

**AGGREGATE SPREADERS**

3-31. A typical hopper-type aggregate spreader (Figure 3-12) can handle aggregate ranging from sand to 1 1/2-inch gravel. The rate and depth of application depends on the gate opening, and the width of the spread varies from 4 to 8 feet in 1-foot increments. Depending on the manufacturer, a spreader has two or four traction wheels. The spreader hooks on the rear of a 5- or 20-ton dump truck with a hitch adapter. During operation, the truck backs up, which allows aggregate to be spread ahead of the truck tires, preventing the pickup of bitumen. Never stand on the aggregate in the truck or the spreader. See TM 5-3895-330-10 for further information on aggregate spreaders and their operation.

3-32. The following are types of nonstandard aggregate spreaders:

- **Whirl.** This spreader is essentially a large disk that fits on the rear of a dump truck. The disk is parallel to the ground and slings the aggregate in a circle as it rotates.
- **Self-propelled.** This spreader is similar to an asphalt finisher. A hopper in the rear receives aggregate from a dump truck; and a
conveyor transports the aggregate through the machine to the front, where augers distribute the material. The aggregate goes through an adjustable screen, which drops large aggregate first and covers it with fine material. A self-propelled spreader provides the greatest degree of control and the least amount of segregation of any aggregate spreader.

SURFACE-TREATMENT COMBINE

3-33. A surface-treatment combine is a combination aggregate spreader and bituminous distributor. A fairly recent development, it has a row of spray bars behind the front wheels. An aggregate spreader, which is similar to the self-propelled type, is located between the spray bars and the rear wheels. Civilians currently use the combine on a limited basis.