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DIVISION 150
EQUIPMENT

SECTION 151

COMPACTION EQUIPMENT

151.1 GENERAL

Use rollers and compaction equipment of standard manufacture. Use self-propelled rollers capable of reversing direction without backlash. Use rollers with positive, accurate steering control. Use adequately powered trucks or tractors for towed-type rollers. Equip rollers with self-cleaning devices that prevent material from adhering to the wheels, drums or tamping surfaces.

If a numerical density is specified, the Engineer may waive the roller weight requirement if the roller compacts the material to the specified density. If a numerical density is not specified, the Engineer may waive the roller weight requirement, if the roller performed satisfactorily on a previous KDOT project.

151.2 TAMPING (SHEEPSFOOT) ROLLERS

Use either towed or self-propelled tamping rollers that can obtain the required compaction.

Additional requirements for non-vibratory, tamping rollers:

- A metal roller, drum or shell with tamping feet projecting a minimum of 6 ½ inches from the surface of the roller, drum or shell;
- The cross-section area of each tamping foot, measured perpendicular to the axis of the tamping foot, shall be 4 to 12 square inches;
- Tamping feet spaced 6 to 12 inches, measured diagonally center to center; and
- If the tamping roller is used to obtain Type B compaction, the weight is such that the load on each tamping foot is a minimum of 200 pounds per square inch.

151.3 PNEUMATIC-TIRED ROLLERS

Use either towed or self-propelled pneumatic-tired rollers that can obtain the required compaction. Equip with scrapers to remove material buildup from drum surface. Provide the Engineer with a suitable gauge to check the tire pressure of pneumatic-tired rollers.

Additional requirements for pneumatic-tired rollers:

a. Light Pneumatic-Tired Rollers

- Tires with wide, smooth treads and uniform air pressure;
- Tires on the front and rear axles staggered to provide complete coverage of the area the roller travels over; and
- Sufficient weight to provide a minimum of 225 pounds per inch of tire width.

b. Heavy Towed-Type Pneumatic-Tired Rollers

- Tires with wide, smooth treads and uniform air pressure;
- Single axle rollers; and
- A weight of 10 to 50 tons.

c. Heavy Self-Propelled Pneumatic-Tired Rollers

- Tires with wide, smooth treads and uniform air pressure;
- Tires on the front and rear axles staggered to provide complete coverage of the area the roller travels; and
- A weight of 8 to 30 tons.

151.4 SMOOTH-FACED STEEL ROLLERS

Use either towed or self-propelled smooth-faced steel rollers that can obtain the required compaction.

Additional requirements for smooth-faced steel rollers:

a. Smooth-Faced Steel Trench Rollers

- Smooth faces on all steel rollers;

- Equip with water tanks and sprinkling devices to wet the rollers;
- Equip with scrapers to remove material buildup from drum surface; and
- Sufficient weight to provide a minimum of 300 pounds per inch of steel roller width.

b. Towed-Type Smooth-Faced Steel Rollers
- Smooth faces on all steel rollers;
- A minimum of 48 inches effective steel roller width;
- Equip with water tanks and sprinkling devices to wet the rollers;
- Equip with scrapers to remove material buildup from drum surface; and
- Constructed so that the weight can be varied from 200 to 300 pounds per lineal inch of steel roller width.

c. Self-Propelled Smooth-Faced Steel Rollers
(1) Two-Axle Tandem Smooth-Faced Steel Rollers
- Smooth faces on all steel rollers;
- Equip with water tanks and sprinkling devices to wet the rollers;
- Equip with scrapers to remove material buildup from drum surface; and
- A weight of 8 to 12 tons.

(2) Three-Axle Tandem Smooth-Faced Steel Rollers
- Smooth faces on all steel rollers;
- Equip with water tanks and sprinkling devices to wet the rollers;
- Equip with scrapers to remove material buildup from drum surface; and
- A minimum weight of 12 tons.

(3) Three-Wheeled Smooth-Faced Steel Rollers
- Smooth faces on all steel rollers;
- Equip with water tanks and sprinkling devices to wet the rollers;
- Equip with scrapers to remove material buildup from drum surface; and
- A weight of 8 to 12 tons.

151.5 SELF-PROPELLED VIBRATORY ROLLERS

Use vibratory rollers that can obtain the required density. Operate the vibratory roller at the frequency and amplitude necessary to achieve the desired compaction without causing objectionable undulations, fracturing of aggregates or surface defects. If pneumatic tires are used on the vibratory roller, equip the roller with smooth tires.

Provide vibratory rollers for use on earthwork and aggregate bases meeting the speed and frequency ranges (vibrations per minute) shown in **TABLE 151-1**. Operate rollers at high amplitude, unless otherwise directed. Coordinate the roller speed and the vibrations per minute to achieve a minimum of 6 impacts per linear foot.

TABLE 151-1: AGGREGATE BASE AND EARTHWORK
Impacts per Linear Foot

Roller Speed MPH (ft./Min)	Vibrations Per Minute							
	1000	1200	1400	1600	1800	2000	2200	2400
1.0(88)	11.4	13.6	15.9	18.2	20.5	22.7	25.0	27.3
1.5(132)	7.6	9.1	10.6	12.1	13.6	15.2	16.7	18.2
2.0(176)	--	6.8	8.0	9.1	10.2	11.4	12.5	13.6
2.5(220)	--	--	6.4	7.3	8.2	9.1	10.0	10.9
3.0(264)	--	--	--	6.1	6.8	7.6	8.3	9.1
3.5(308)	--	--	--	--	--	6.5	7.1	7.8
4.0(352)	--	--	--	--	--	--	6.3	6.8
4.5(396)	--	--	--	--	--	--	--	6.1

On asphalt pavement, operate the vibratory rollers at a speed and frequency range to provide a minimum of 10 impacts per linear foot, as shown in **TABLE 151-2**. Provide amplitude adjustable rollers. Operate rollers at low amplitude, unless otherwise directed. Provide rollers with a minimum of 1800 vibrations per minute (VPM) and a static force on drums of 135 pounds per linear inch (PLI) of roller width.

TABLE 151-2: ASPHALT PAVING
Impacts per Linear Foot

Roller Speed MPH (ft./Min)	Vibrations Per Minute											
	1800	2000	2200	2400	2600	2800	3000	3200	3400	3600	3800	4000
1.0(88)	20.5	22.7	25.0	27.3	29.5	31.8	34.1	36.4	38.6	40.9	43.2	45.5
1.5(132)	13.6	15.2	16.7	18.2	19.7	21.2	22.7	24.2	25.8	27.3	28.8	30.3
2.0(176)	10.2	11.4	12.5	13.6	14.8	15.9	17.0	18.2	19.3	20.5	21.6	22.7
2.5(220)	8.2	9.1	10.0	10.9	11.8	12.7	13.6	14.5	15.5	16.4	17.3	18.2
3.0(264)	6.8	7.6	8.3	9.1	9.8	10.6	11.4	12.1	12.9	13.6	14.4	15.2
3.5(308)	5.8	6.5	7.1	7.8	8.4	9.1	9.7	10.4	11.0	11.7	12.3	13.0
4.0(352)	5.1	5.7	6.2	6.8	7.4	8.0	8.5	9.1	9.7	10.2	10.8	11.4
4.5(396)	4.5	5.1	5.6	6.1	6.6	7.1	7.6	8.1	8.6	9.1	9.6	10.1
5.0(440)	4.1	4.5	5.0	5.5	5.9	6.4	6.8	7.3	7.7	8.2	8.6	9.1

Operate rollers at a speed and frequency range above the bold line.

151.6 MECHANICAL AND HAND TAMPERS

Use mechanical or hand operated tampers of standard manufacture that can obtain the required compaction in small, irregular areas where the use of conventional equipment is impracticable.

SECTION 152

HAULING AND WEIGHING EQUIPMENT

152.1 HAULING EQUIPMENT

a. Aggregate Hauling Equipment. Use vehicles with dump bodies of standard manufacture, designed for dumping materials in windrows or into spreader boxes. Use vehicles with bodies constructed and maintained to prevent loss of materials during the hauling operations. Equip the vehicles with dump controls that are operated from the driver's seat.

b. Asphalt Hauling Equipment. Use vehicles with dump bodies of standard manufacture, designed for dumping materials in windrows or into spreader boxes. Use vehicles with smooth metal bodies constructed and maintained to prevent loss of materials during the hauling operations. Equip the vehicles with dump controls that are operated from the driver's seat.

During the hauling operations apply a thin coat of an approved material to prevent the asphalt from adhering to the beds. The Engineer must approve the coating material before it is used. Do not use petroleum derivatives for coating the beds. Remove any excess coating material before loading the asphalt into the bed.

Equip each vehicle with a tarpaulin to protect the asphalt from the weather. Use tarpaulins that are waterproof and free of holes and tears. The tarpaulins shall be large enough to cover the top of the load and extend down over the sides and tailgate of the vehicle. Use enough tie-down points to secure the tarpaulin to the vehicle and prevent flapping in the wind during the hauling operations. The Engineer may approve alternate methods of securing the tarpaulin, provided the asphalt is completely covered, and the tarpaulin is secured.

c. Water Hauling and Distributing Equipment. Use pneumatic-tired water equipment (calibrated tanks of 1000 gallon capacity or larger) equipped with spray bars and pressure pumps to haul and distribute water. Equip all water tanks with control valves that are operated from the driver's seat. Provide the Engineer with the means to verify the calibration of the water tanks.

The requirement for the pressure pump may be waived on force account projects, subgrade modification projects and fly ash treated subgrade projects.

Water may also be transported by pipelines equipped with calibrated meters placed as close to the point of delivery as possible. Provide the Engineer with the means to verify the calibration of the water meters.

152.2 WEIGHING EQUIPMENT

Use and maintain weighing devices (mechanical or electronic) at locations approved by the Engineer. Have the weighing devices tested, certified and sealed by a licensed service company.

Have the licensed service company test, certify and seal the weighing devices according to:

- all applicable laws for commercial weighing and measuring devices;
- the appropriate Examination Procedure Outline (EPO) prescribed by the Kansas Department of Agriculture, Division of Weights and Measures; and
- the weighing devices shall be accurate to the applicable tolerances specified in the National Institute of Standards and Technology (NIST) Handbook 44 (current edition), United States Department of Commerce, Technology Administration.

Have the weighing devices tested, certified and sealed:

- after each setup and before being used on the project (except for small units such as 3 sack mixers which are moved frequently);
- at 6 month intervals during the life of the project;
- when the weighing devices are repaired; and
- at any other time deemed necessary by the Engineer.

Arrange the beams, dials, platforms and other scale equipment for safe and convenient viewing by the operator and the Engineer. Provide and maintain scale houses as necessary. Install and maintain vehicle scales with

the platform level, and rigid bulkheads at each end. Use a platform of adequate length to weigh (in 1 operation) the longest truck or truck-trailer combination used on the project. Maintain the approaches to the scale platform.

Provide certified test standards (a minimum of 500 pounds) for use on the project.

For weighing procedures and scale operator requirements see **SECTION 109**.

SECTION 153

MIXING PLANT FOR STABILIZED BASE AND SHOULDERS

153.1 CENTRAL MIXING PLANT

Use a stationary mechanical mixing plant designed to blend component aggregates and distribute the required moisture uniformly throughout the mixture. Provide the Engineer with the means to verify the calibration of the plant.

153.2 TRAVELING MIXING PLANT

Use a traveling mechanical mixing plant designed to blend component aggregates and distribute the required moisture uniformly throughout the mixture without damaging the subgrade. Provide the Engineer with the means to verify the calibration of the plant.

SECTION 154

CONCRETE PAVEMENT AND CONCRETE STRUCTURE EQUIPMENT

154.1 CONCRETE BATCHING AND MIXING EQUIPMENT

a. Batching Equipment. Use standard manufacture batching equipment consisting of bins, weighing hoppers and weighing devices. Use batching equipment designed and constructed to discharge freely, thus eliminating accumulation of materials in bins or weighing hoppers. Use batching equipment with bins that have separate compartments for each size of aggregate.

Use weighing devices that are tested, certified and sealed according to **subsection 152.2**. If the cement (or fly ash) is measured by weight, use a weighing device and weighing hopper separate from those used for other materials. Equip the cement or fly ash weighing hopper with a sealed and vented cover to prevent dusting during operation.

b. Central and On-Site Concrete Mixers. Use standard manufacture concrete mixers capable of combining aggregate, cement (or fly ash) and water (and admixtures, if any) into a uniform mixture within the specified mixing period. Use mixers capable of discharging the concrete without segregating the mixture.

Additional requirements for central and on-site concrete mixers:

- A manufacturer's plate attached to the mixer listing the capacity of the drum (volume of mixed concrete) and the speed of rotation of the mixer drum or blades;
- A timing device that automatically locks the discharge lever when the drum is charged, and releases it at the end of the mixing period;
- A warning device, either audible or visible, that signals the release of the discharge lever (end of the mixing period);
- An automatic water-measuring device (measured either by weight or volume, accurate within 1% of the quantity required) capable of discharging the desired quantity of water into the mixer drum; and
- A semi-automatic, air-entraining agent measuring device capable of discharging the desired quantity of air-entraining agent into the flow (of the mixing water) of the water discharge line.

Provide the Engineer with the means to verify the calibration of the concrete mixers.

Clean the mixers at suitable intervals. Periodically examine the concrete mixers for changes in condition. Acceptable concrete mixers shall consistently produce well mixed, uniform concrete.

c. Truck Mixers and Truck Agitators.

(1) Truck Mixers. Use standard manufacture truck mixers capable of combining aggregate, cement (or fly ash) and water (and admixtures, if any) into a uniform mixture within the specified number of revolutions. Use truck mixers capable of discharging the concrete without segregating the mixture.

Unless the truck mixer is equipped with automatic measuring and dispensing devices for water and air-entraining agent, use central measuring and dispensing equipment as specified in **subsection 154.1b**.

Additional requirements for truck mixers:

- A drum of such size that the rating (volume of concrete) does not exceed ⅔'s of the gross volume (disregarding the blades) of the mixer;
- For truck mixers with automatic water measuring devices, use a water measuring device (accurate within 1% of the quantity required) capable of discharging the desired quantity of water into the mixer drum;
- A manufacturer's plate attached to the mixer listing the manufacturer's recommended operating speed for mixing or agitating. If the mixer is used both for mixing and for agitating, the maximum speed for agitation shall be less than the minimum mixing speed; and
- A revolution counter that indicates the number of revolutions of the drum or the blades.

(2) Truck Agitators. Use standard manufacture truck agitators capable of agitating and discharging the concrete without segregating the mixture.

Additional requirements for truck agitators:

- A drum of such size that the rating (volume of concrete) does not exceed 80% of the gross volume (disregarding the blades) of the agitator;
- A manufacturer's plate attached to the agitator listing the manufacturer's recommended operating speed for agitating; and
- A revolution counter that indicates the number of revolutions of the drum or the blades.

(3) Provide the Engineer with the means to verify the calibration of the truck mixers and agitators.

Clean the truck mixers and truck agitators at suitable intervals. Periodically examine the truck mixers and agitators for changes in condition. Acceptable truck mixers (agitators) shall consistently produce (deliver) well-mixed, uniform concrete. If the Engineer questions the performance of a truck mixer (or truck agitator), slump tests from samples taken at the beginning, the mid-point and the end of the load, may be conducted. If the results of the slump tests vary more than ½ inch when the average slump is 3 inches or less, or more that 1 inch when the average slump is greater than 3 inches, the Engineer will reject the truck mixer (or truck agitator) until it is cleaned and repaired.

d. Continuous Volumetric Concrete Mixers. Use standard manufacture continuous volumetric concrete mixers capable of combining aggregate, cement (or fly ash) and water (and admixtures, if any) into a uniform mixture within the specified mixing period.

Additional requirements for continuous volumetric concrete mixers:

- A capacity to carry (in separate compartments for each ingredient) enough of each individual ingredient to produce a minimum of 6 cubic yards of concrete;
- The capability of producing a thoroughly mixed uniform concrete that complies with the consistency requirements of **SECTION 401**;
- A recording meter capable of measuring the cement as it is introduced into the mixture.
- An adjustable flow control valve capable of controlling the flow of water and admixture as they are introduced into the mixture;
- A water flow meter capable of indicating to the nearest 0.10 gallons, the quantity of gallons used; and
- The capability of being calibrated to automatically proportion and blend all components of the concrete mixture on a continuous or intermittent basis, as required.

Calibrate the continuous volumetric concrete mixer according to the manufacturer's recommendations. Provide the Engineer with the means to verify the calibration of the continuous volumetric concrete mixer.

The Engineer will allow operation of the continuous volumetric concrete mixer, provided the concrete produced is within the limits of the specifications.

e. Small-Quantity Concrete Mixers. Use standard manufacture small-quantity concrete mixers capable of combining aggregate, cement (or fly ash) and water (and admixtures, if any) into a uniform mixture. Use self-powered concrete mixers capable of mixing a volume of concrete that requires 1 sack (minimum) of cement.

The Engineer must approve the mixer before it is used. Clean the mixers at suitable intervals. The Engineer will periodically examine the concrete mixers for changes in condition. Acceptable concrete mixers shall consistently produce well mixed, uniform concrete.

f. Non-Agitating Units. Use standard manufacture, non-agitating units capable of transporting and discharging the concrete without segregating the mixture. Use non-agitating units that have smooth, watertight bodies with rounded corners.

Clean the non-agitating units at suitable intervals. The Engineer will periodically examine the non-agitating units for changes in condition. Acceptable non-agitating units shall consistently deliver and discharge non-segregated concrete.

154.2 VIBRATORS

a. General. Provide the proper testing equipment to determine the frequency of the impulses of the vibrators.

b. Vibrators Used With Epoxy Coated Reinforcing Bars. In addition to the vibrator requirements for different uses, when epoxy coated reinforcing steel is involved use vibrators with heads of rubber or other resilient material. Rubber covers securely fastened over steel heads shall be acceptable. The requirement does not apply to dowel bars and tie bars for pavement.

c. Vibrators for Structures. Use internal type (spud or tube) vibrators. Use vibrators with frequencies of vibration of a minimum of 8000 cycles or impulses per minute under load, and with adequate amplitude to consolidate the concrete. Use vibrators that can enter the forms and operate around the reinforcing bars.

Do not use vibrators designed for use on the forms or the reinforcing bars.

Use of any internal type vibrator is contingent upon its ability to properly consolidate the concrete.

d. Vibrators for Bridge Decks. Use a mechanical device on which internal type (spud or tube) vibrators (of the same type and size) are mounted with maximum spacing of 12 inch centers. Mount the vibrators so that the vibrators enter the concrete in a vertical position under the influence of their own weight, with enough flexibility to work themselves around the reinforcing bars. The mechanical device may be mounted on the finishing machine or on an independent framework pulled along the grade rails.

Additional requirements for vibrators for bridge decks:

- The diameter of the head of the vibrator shall be 1 ¾ to 2 ½ inches;
- The frequency of vibration under load shall be 8,000 to12,000 vibrations per minute;
- The average amplitude shall be 0.025 to 0.05 inch; and
- The minimum radius of action shall be a minimum of 7 inches.

To verify compliance, provide the Engineer with a copy of the manufacturer's specifications for each type and brand of vibrator used on the project.

e. Vibrators for Rigid Pavement. Use either internal type (spud or tube) vibrators or surface type (pan or screed) vibrators. Use vibrators mounted on the concrete spreader, the finishing machine or a separate carriage. Use vibrators capable of vibrating the full depth of the rigid pavement without coming in contact with the joint, load transfer device, subgrade or forms. Vibrators should operate only when the machine the vibrators are attached to is moving.

Additional requirements for vibrators for rigid pavement:

- The frequency of vibration of surface, pan or screed vibrators shall be a minimum of 3,500 cycles per minute;
- The frequency of vibration of immersion tube vibrators attached to the paving machine shall be a minimum of 5,000 cycles per minute; and
- The frequency of vibration of immersion spud vibrators (both hand operated and gang mounted) shall be a minimum of 8,000 cycles per minute.

154.3 SUBGRADE TRIMMERS

a. Fixed Form Subgrade Trimmer. Use a standard manufacture subgrade trimmer that rides on the fixed forms. Use a subgrade trimmer capable of cutting (with a continuous cutting edge) the subgrade to the specified cross-section. Do not use subgrade trimmers with spikes or teeth (scratch planers).

b. Slip Form Subgrade Trimmer. Use a standard manufacture subgrade trimmer that is automatically controlled (from a reference system) in regard to both line and grade.

The Engineer may waive the use of automatically controlled equipment on areas of narrow or irregular dimensions. Automatically controlled equipment is not required on projects with less than 20,000 square yards of subgrade or treated subbase.

154.4 FIXED FORM PAVING EQUIPMENT

a. Concrete Spreader. Use a standard manufacture self-propelled concrete spreader equipped with a power driven device for transversely spreading the concrete uniformly across the subgrade. Use a concrete spreader that rides on the fixed forms and is capable of spreading and striking-off the concrete.

The Engineer may waive the use of a self-propelled concrete spreader in areas of narrow or irregular dimensions.

b. Concrete Finishing Machine. Use a standard manufacture self-propelled concrete finisher capable of spreading and consolidating the concrete to the specified cross-section. The concrete finisher may be mounted on the same carriage as the concrete spreader.

The use of any concrete finishing machine is contingent upon its performance. If any finishing machine fails to produce the specified cross-section or consolidation, the Engineer may require adjustment, repair or replacement of the machine.

154.5 SLIP FORM PAVING EQUIPMENT

Use standard manufacture, slip form paving equipment capable of spreading, consolidating, screeding and float finishing freshly placed concrete in one pass. Use slip form equipment capable of producing a homogeneous pavement to the specified cross-section, profile and density.

Use slip form paving equipment that is automatically controlled (from a reference system) in regard to line and grade.

Use an automated electronic vibrator monitoring system on all mainline paving. (This system is not required on shoulders, if a separate paver is used strictly for shoulders.) Use a system capable of displaying the operating frequency of each individual internal vibrator. Equip the monitoring device with a readout display near the operator's controls visible to the paver operator and the inspector. Operate the monitoring device continuously while paving, and display all vibrator frequencies with manual or automatic sequencing among all individual vibrators. Equip the monitoring system to record, at a minimum, the clock time, station location, paver track speed and operating frequency of individual vibrators. Make recordings after each 25 feet of paving or after each 5 minutes of time. Provide an electronic record of the data to the Engineer daily for the first 3 days of paving and weekly thereafter. The Engineer may determine if a more frequent submission is necessary, particularly if equipment malfunctions occur.

If the electronic monitoring system fails to operate properly, manually check the vibrators, immediately. If the vibrators are functioning properly, paving may continue but make all efforts to correct the problem within 3 paving days. The Engineer may allow additional time if circumstances are beyond the Contractor's control.

Use slip form paving equipment equipped with traveling side forms. The traveling side forms shall trail behind the paver a sufficient distance to prevent edge slump of the concrete pavement. The top finishing edge of the traveling side forms shall have a maximum radius of ¼ inch.

Use all the component parts recommended by the manufacturer of the slip form paving equipment (paving train).

If any unit of the paving train shall operate on adjacent pavement, protect the adjacent pavement.

154.6 LONGITUDINAL FINISHER

Use a standard manufacture longitudinal finisher capable of producing a smooth surface to the specified cross-section. The longitudinal finisher may operate either mechanically or manually.

Adjust and operate the longitudinal finisher (in conjunction with the finishing screed) so that a small roll of mortar is carried ahead of the float.

154.7 CONCRETE PAVEMENT TEXTURING EQUIPMENT

a. Burlap Drag. Use a drag consisting of a seamless strip of damp burlap, artificial turf or cotton fabric. Use a drag that produces a uniform, gritty texture when pulled longitudinally along the full width of the pavement.

Use only drags that are clean and free of encrusted mortar.

b. Transverse Grooving Equipment. Use standard manufacture transverse grooving equipment capable of transversing the width of the pavement in a single pass. Use transverse grooving equipment with a metal comb that is capable of producing a uniform pattern of transverse grooves approximately 3/16 inch wide, spaced at ¾ inch centers and ⅛ to ¼ inch deep.

The Engineer may accept transverse grooving equipment with a fluted float (instead of a metal comb) provided the fluted float produces transverse grooves similar in dimension to the requirements of the metal comb.

Small or irregular areas may be grooved by hand methods.

c. Longitudinal Grooving Equipment. Use standard manufacture longitudinal grooving equipment capable of covering the width of the pavement in a single pass. Use longitudinal grooving equipment with a metal comb that is capable of producing a uniform pattern of longitudinal grooves approximately 3/16 inch wide, spaced at ¾ inch centers and ⅛ to ¼ inch deep.

The Engineer may accept longitudinal grooving equipment with a fluted float (instead of a metal comb) provided the fluted float produces longitudinal grooves similar in dimension to the requirements of the metal comb.

Small or irregular areas may be grooved by hand methods.

154.8 CONCRETE CURING COMPOUND DISTRIBUTOR

Use standard manufacture concrete curing compound distributors capable of continually mixing and uniformly spraying liquid membrane-forming compounds at the minimum rate of 1 gallon per 150 square feet of surface. Use concrete curing compound distributors capable of spraying both the surface and the edges of the slab at the same time.

154.9 CONCRETE SAWING EQUIPMENT

Use standard manufacture concrete sawing equipment capable of making cuts to the specified dimensions. Use concrete saws with either water-cooled diamond-edge blades or abrasive wheel blades.

Other sawing devices are acceptable based on performance, and with the approval of the Engineer.

Keep at least one stand-by saw and an adequate supply of blades on the project during the sawing operations.

SECTION 155

ASPHALT SURFACING AND ASPHALT RECYCLING EQUIPMENT

155.1 EQUIPMENT FOR HEATING ASPHALT MATERIALS

a. Use equipment for heating asphalt materials at project asphalt plant sites by one of the following methods:

- Circulate steam, hot gases or hot oil through coils of a tank.
- Circulate the asphalt material around a system of heated coils or pipes.
- Circulate the asphalt material through a system of coils or pipes enclosed in a heated jacket.
- Other approved means subject to the requirements of this specification.

Construct the heating device to prevent direct flame from striking the surface of the coils, pipes or jacket through which the asphalt material is circulated. Operate the heating device in a manner that shall not damage or change the characteristics of the asphalt material.

b. Railroad tank cars or truck tankers that have defective coils, or from which the coils have been removed, shall be rejected by the Engineer unless the Contractor can provide satisfactory auxiliary means for heating the asphalt material without contamination and introducing moisture. Do not use a tanker connection or any other equipment by means of which free steam can be introduced directly into the asphalt material as a means of agitation or auxiliary heating.

155.2 ASPHALT DISTRIBUTOR

a. Use equipment for the distribution of asphalt materials equipped with the following appliances or devices:

- Tachometers;
- Pressure gauge;
- Adjustable length spray bars;
- Separate power unit and pump on the distributing system or hydrostatic drive system;
- Heating coils and burner;
- Thermometer well and accurate thermometer;
- Measuring sticks; and
- Quick opening gate in the dome.

Mount all distributors and supply tanks on trucks or trailers equipped with pneumatic tires. Design the units so that no rutting or other injury to the road surface shall result. Provide sufficient power to maintain the desired speed of the equipment during operation.

The tachometer designating the speed of the truck shall be a separate operating unit attached to the truck. Equip the tachometer with a large gauge approximately 5.5 inches in diameter and graduated in units so the speed of the truck can be determined within limits of approximately 10 feet per minute. Locate the gauge so that it can be easily read at all times by both the driver and the Engineer.

Equip the distributor with either a tachometer attached to the pump shaft and calibrated to indicate revolution per minute, or a pressure gauge placed in the distributing system and calibrated to indicate pounds per square inch or gallons per minute by which the flow of asphalt materials can be regulated.

The spray bars and nozzles shall be constructed to accomplish the following:

- Permit adjustment for length in increments of 1 foot for any length up to 16 feet;
- Permit vertical adjustment of all nozzles to the desired height above the road surface and conforming to the roadway crown;
- Permit lateral shifting of the entire spray bar during operation;
- Prevent clogging of the nozzles; and
- Provide positive and immediate cut-off when distribution of asphalt material ceases.

The power unit and pump distribution system requirements are as follows:

- Capacity of a minimum of 250 gallons per minute;
- Equipped with a bypass into the supply tank;
- Capable of distributing a uniform and constant flow of asphalt material through all nozzles at a pressure between 30 to 50 pounds per square inch; and
- Capable of being calibrated and adjusted to accurately distribute asphalt material within 0.01 gallon per square yard for any quantity from 0.1 to 1 gallon per square yard.

b. Calibrate and check all distributors before using on a KDOT project. The calibration of the tank and preparation of the certificate shall be performed by the DME in the District in which the distributor is first used. Provide all equipment, materials and assistance necessary for the calibration.

The DME will give a certificate of approval to the distributor operator indicating the record of the calibration and check. Keep this certificate in the distributor at all times and make it available to the Engineer in charge on each project on which the distributor is used. Failure to present the certificate shall require a re-check, and if deemed necessary, a re-calibration of the distributor before it may be used on a project. The certificate may be revoked at any time due to unsatisfactory performance of the distributor. It shall be returned only when satisfactory repairs or adjustments have been made.

Each subsequent year, the operation of the distributor must be checked by the Engineer the first time it is used. When the operation is found to be satisfactory, the distributor may be used. The Engineer making the check will sign and date the certificate.

155.3 STORAGE OR SURGE BINS

a. When a storage or surge bin is used with any type of plant, the following items are required as a minimum.

(1) Design, equip and use the bin to prevent segregation.

(2) Protect the belt leading from the drum discharge to the bin to prevent heat loss due to wind blowing on the material.

(3) Use a "Gob-Hopper" or other type of device approved by the Engineer to help prevent segregation of the mix as it falls into the bin or silo.

(4) Use a Tel-Tale device located at the top of the tapered portion of the bottom of the bin to indicate when the level of the asphalt mixture in the bin has been lowered to that point. In the case of special designed bins (such as full length tapered bins), locate the device at the point designated by the Engineer. Do not lower the mixture below this point except to clean out the bin, when plant operations are being terminated at the end of the day and such other times as deemed necessary by the Engineer.

Interconnect the Tel-Tale device with the controls of the gate in the bottom of the bin to close the gate automatically when the mixture in the bin has been lowered to the level of the Tel-Tale device. Provide a means of over-riding these controls solely for the purpose of cleaning out the bin at the termination of plant operation. The material in the bottom of the bin below the device may be used when the bin is cleaned out, provided the Engineer approves the material.

(5) Do not keep hot asphalt mixtures in storage or surge bins longer than 3 hours without prior approval by the Engineer.

b. See **subsection 155.6a.(6)** for use of surge or storage bins.

c. If the Engineer determines that segregation is occurring, use of storage or surge bins may be prohibited.

155.4 ASPHALT PAVER

Acceptable asphalt pavers are self-contained, power-propelled units, equipped with an automatically controlled activated screed or strike-off assembly, and heated if necessary. They are capable of spreading and finishing courses of asphalt material in lane widths applicable to the specified section and thickness shown in the Contract Documents. Pavers used for shoulders and similar construction shall be capable of spreading finishing courses of asphalt material to the width shown in the Contract Documents.

Equip the paver with an approved automatic screed control system capable of grade reference and transverse slope control. The automatic controls shall include a system of sensor operated devices that sense and

follow a reference line or surfaces on one or both sides of the paver as required. Maintain the screed at the proper elevation at each end by controlling the elevation of one end while automatically controlling the transverse slope, or by controlling the elevation of each end independently.

With the screed or strike-off assembly, produce a finished surface of the required evenness and texture without tearing, shoving or gouging the mixture.

Equip the paver with a receiving hopper having sufficient capacity for a uniform and continuous spreading operation. Equip the hopper with a distribution system to place the mixture uniformly in front of the screed. Pickup attachments used to feed the hopper may not exert any vertical load on the paver and shall be capable of picking up and loading substantially all of the material on the surface.

When laying mixtures, the paver shall be capable of being operated at variable forward speeds consistent with satisfactory laying of the mixture.

155.5 MATERIAL TRANSFER DEVICE

Mobile conveyors, shuttle buggies, material transfer vehicles, materials transfer paver and pick-up devices are considered material transfer devices. Provide a self-propelled material transfer device, capable of moving independent of the paver or attached to the paver. Equip the materials transfer device to perform additional mixing of the material, and then deposit the mixture into the paver at a uniform temperature and consistency.

Paver hopper inserts shall be required when spillage of the HMA occurs during transfer of the material.

155.6 ASPHALT PLANTS

Plants used for the manufacture of HMA shall consist of a drum mix plant, batch plant or continuous mix plant. Provide equipment complying with the requirements specified below, having capacity to adequately handle the proposed asphalt construction, and meeting the approval of the Engineer.

Continued use of any hot mix plant is on the condition that the Contractor is fully responsible for producing material that complies with contract requirements.

a. Requirements for All HMA Plants.

(1) Uniformity. Design, coordinate and operate the plants to produce a uniform mixture.

(2) Proportioning Equipment. The Engineer may require locking or sealing of any automated proportioning equipment that can be manually manipulated.

(3) Heating and Storage Tanks for Asphalt Material. Use storage tanks for asphalt material that have sufficient capacity to provide for continuous operation. They shall be capable of uniformly heating and holding the asphalt material at the required temperature range without damaging or changing its characteristics. Direct flame against the tanks is prohibited. Design the circulating system to obtain proper and continuous circulation during the operating period. Provide an accurate procedure for determining the amount of asphalt material in the tanks at any time. Document and substantiate the calibration data. Situate and construct the tanks so the level of material can be safely and accurately measured at any time. Set the tanks as nearly level as possible. Include a means of obtaining samples of asphalt material from the delivery line to the plant in the system.

(4) Cold Feed Aggregate Bins. Provide separate cold feed bins for each aggregate size used, unless blending is permitted by methods approved by the Engineer. Use cold feed bins with sufficient capacity to maintain a continuous flow of material. Construct the bins to prevent any spilling or leakage from one bin to another. Each bin shall have a belt feeder equipped with an adjustable gate or an adjustable drive, or both, that can be calibrated and controlled. Provide a uniform distribution of aggregate on the conveyor belt. Equip each bin with a device that shall detect any reduction or interruption of aggregate flow and actuate a visual or audible signal at locations approved by the Engineer.

(5) Thermometric Equipment. Equip the plant with a sufficient number of thermometric instruments to control the temperature of the aggregate and the asphalt material. Use instruments capable of recording temperature on a chart over each 24-hour period with a maximum chart gradation of 15 minutes and 10ºF. Use a 24-hour clock or designate AM and PM on the chart. The Engineer shall retain all temperature records as part of the contract records. Install the units separate from the plant in a readily accessible location.

Locate the actuating unit for recording temperature either in the storage tank or in the feed line between the pump and the discharge valve.

Locate the actuating unit for recording aggregate temperature and hot mix as specified for each type of plant.

(6) Use of Storage Bins and Batchers. When used with a storage bin, design and operate these plants so the transfer of hot mix from the drum to the storage bin shall not cause segregation of the mix, and the batcher can be operated according to **subsection 602.4a.(3)(d)**.

Equip all storage bins with controls capable of maintaining a specified minimum level or amount of hot mix in the bin at all times during production.

If the amount of hot mix in the bin can be determined by reading the output of load cells or other approved sensors, the Engineer shall specify the minimum amount of material in tons. Otherwise, the minimum level of hot mix is the top of the tapered portion of the bin or at the point designated by the Engineer on special designed bins.

Set the controls to close and lock the bin gate when the specified minimum amount or level is reached. Override of the lock is permitted only to clean out the bin at the end of a production run.

Equip every storage bin with a batcher at the top, located so the hot mix is discharged vertically from the batcher into the center of the bin. The Engineer may approve other equipment such as a rotating chute. Do not load the storage bin directly from a belt or other conveyor. Cover the belts carrying hot mix to prevent excess heat loss.

Establish control of the batcher gates so the batcher shall operate as specified in **subsection 602.4a.(3)(d)** throughout the output range of the plant.

(7) Dust Collectors. Equip the plant with an approved dust collector, bag house or other type of collector that complies with limit particulate emissions standards.

Dispose of all waste material in a suitable manner.

Equip the plant to prevent particulate leakage.

(8) Air Emission Permit. Provide a copy of an Air Emission Permit issued by the Kansas Department of Health and Environment (KDHE) to the Engineer before installing a hot mix plant. It is the Contractor's responsibility and expense to satisfy the KDHE requirements.

(9) Safety Requirements. Provide adequate and safe access to sampling points and other locations where checking of plant operations is necessary. Thoroughly guard and protect all gears, pulleys, chains, sprockets and other dangerous moving parts. When required by the Engineer, provide access to the top of truck bodies by a platform or other suitable device to enable the Engineer to obtain samples and temperature data.

b. Requirements for Drum Mix Plants.

(1) General. The plant shall be specifically designed for drum mixing and be capable of satisfactorily heating, drying and mixing the hot mix.

(2) Cold Aggregate Feed System. Use belt scales for positive weight measurement of the combined cold aggregates. Continuously record the amount of cold aggregate using a non-set-back recorder. The belt scale shall be accurate within 2% by weight of the material being measured over any given period of time. Calibrate the belt scales at intervals as directed by the Engineer. Provide a weight system automatically coupled with the asphalt flow to maintain the required proportions.

(a) Sampling. Provide safe, adequate and convenient facilities for obtaining representative samples of the combined cold aggregate. Provide a sampling device capable of producing a sample of proper size (large enough to be representative, but small enough to be carried safely by 2 people) from the full width of the combined aggregate flow, while the plant is operating at regular production rate.

(b) Reclaimed Asphalt Pavement (RAP) Material Conveyor. If the plant is used for recycling, a dual weighing system is required to control delivery of virgin aggregate and RAP material to the drum. Equip the system with interlocking mechanisms that shall accurately deliver virgin aggregates and RAP material in proper proportions. Belt scales for the RAP material shall comply with **subsection 155.6b.(2)**.

(c) Moisture Compensation. Include a moisture compensation device in the cold feed system to correct for the moisture in the aggregate passing over the belt scales.

(d) Weather Protection. Protect belt scales from the effect of wind and weather.

(3) Asphalt Material Feed System. Supply asphalt material to the mixing drum through a continuously registering cumulative indicating meter by a pump specifically designed for drum mix plants. Locate the meter in the asphalt material so it shall register the discharge to the drum. Provide a means to divert the flow into a container for calibration. Supply the meter with a non-set-back register accurate within 2% by weight of the material measured in any given period of time. The register shall record only material delivered to the drum.

(4) Mineral Filler Feed System. Introduce and uniformly disperse fly ash and similar mineral fillers into the drum mixer at the point of introduction of the asphalt without loss to the dust collector system. Use a non-set-back register to record the quantity of mineral filler discharged into the mixer. Equip the delivery system with

variable speed to interlock with the aggregate weigh belt so the total aggregate weight including the mineral filler is indicated to the asphalt proportioning system. Provide a device to indicate that mineral filler is being delivered uniformly to the drum that shall activate a visible or audible signal to the plant operator if the flow is reduced or interrupted.

(5) Calibration of Feed Systems. Enable easy calibration of the aggregate weighing system and the asphalt material meter system. The calibration methods are subject to approval by the Engineer, who may require a schematic diagram of the system.

(6) Mixing Drum. Equip the drum with automatic burner controls to prevent damage to the aggregate or asphalt material. Keep the discharge temperature of the mixture within the range specified in **DIVISION 600** for the type of asphalt material being used. Install the activating unit for recording the asphalt mixture temperature in the discharge chute of the drum mixer.

Use a rate of flow through the drum such that the aggregate and asphalt material form a homogeneous mixture with all particles uniformly coated. Do not exceed the manufacturer's rated capacity.

c. Requirements for Hot Mix Batch Plants.

(1) Dryer. Include one or more dryers in the plant that continuously agitate the aggregate during the heating and drying process. Use dryers that dry and heat all aggregate to specified requirements.

(2) Aggregate Temperature. Install the actuating unit for recording the aggregate temperature where the hot materials flow over it during the proportioning operation.

(3) Hot Aggregate Storage Unit. Configure the unit so the aggregate shall not be segregated and can be discharged into the weigh hopper in a manner that shall not affect the accuracy of weighing.

(4) Weigh Box or Hopper. Include a means for accurately weighing the aggregate in a weigh box or hopper suspended on scales, and of ample size to hold a full batch without running over. The gate shall close tightly so no material is allowed to leak into the mixer while a batch is being weighed.

(5) Asphalt Control. The weigh bucket shall be non-tilting with a loose sheet metal cover. Make the length of the discharge opening or spray bar greater than ¾ the length of the mixer, and make it discharge directly into the mixer. Heat the asphalt material bucket, its discharge valve or valves and spray bar. Provide an asphalt material bucket with a capacity a minimum of 15% in excess of the weight of asphalt material required in any batch. Have a heated quick-acting, non-drip, charging valve located directly over the asphalt material bucket.

Locate a scale dial with a capacity of a minimum of 15% in excess of the quantity of asphalt material used in a batch in full view of the mixer operator. Automatically control the flow of asphalt material to begin when the dry mixing period is over, and all of the asphalt material required for one batch shall be discharged in less than 15 seconds after the flow has started. If an approved metering device is used to control the amount of asphalt material, provide a valve and outlet for checking the meter in the section of line between the charging valve and the spray bar.

(6) Scales. Scales may be of the beam, springless dial or electronic type that complies with **subsection 152.2**. Equip beam scales with a Tel-Tale dial that shall start to function when the load being applied is within 100 pounds of that required. The dials shall be compounding, with full complements of index pointers. Do not place dials to give excessive parallax errors. Locate all dials to be plainly visible to the operator at all times.

(7) Control of Mixing Time. Equip the mixer:

- with an accurate time lock to control the operations of a complete mixing cycle;
- to lock the weigh box gate after charging the mixer until the mixer gate closes at completion of the cycle; and
- to lock the asphalt material bucket throughout the dry mixing period and lock the mixer gate throughout the dry and wet mixing periods.

The dry mixing period is defined as the interval of time between the opening of the weigh box gate and the start of introduction of asphalt material. The wet mixing period is the interval of time between the start of introduction of asphalt material and the opening of the mixer gate.

Perform the setting of time intervals in the presence of the Engineer. The Engineer will then lock the case covering the timing device until such time as a change is to be made in the timing device.

(8) Mixer. Use an approved type of batch mixer capable of producing a uniform mixture.

If not enclosed, equip the mixer box with a dust hood to prevent loss of dust.

The clearance of blades from all fixed or moving parts may not exceed 1 inch, if the maximum size of the aggregate is less or equal to 1 inch. The clearance may not exceed 1 ¼ inches, if the maximum size of the aggregate in the mix exceeds 1 inch.

155.7 SELF-PROPELLED AGGREGATE SPREADER

Use a spreader that is supported by a minimum of 4 wheels with pneumatic tires on 2 axles. Equip the spreader with a means of applying the larger cover coat materials to the surface ahead of the smaller cover coat material so that the required amount of material is deposited uniformly over the full width of the asphalt material.

155.8 SURFACE RECYCLE EQUIPMENT

a. Pre-Heating Unit. Use a self-propelled heating unit, adjustable in width, with ports permitting fuel and forced air injection for proper combustion without excessive smoke. The unit shall be under a closed or shielded hood, capable of heating asphalt pavement to a temperature that allows milling or scarifying to the specified depths. Equip each unit with a water spray system used to wet the adjacent vegetation.

b. Heating Milling Unit. Use a self-propelled unit capable of milling, heating and windrowing the asphalt pavement that is being processed, and meeting **subsection 155.8a**. In addition, equip this unit with automatic grade controls to mill the desired depth of material to be processed.

c. Heating Scarifying Unit. Use a self-propelled unit capable of heating and scarifying the asphalt pavement that is being processed, and meeting **subsection 155.8a**.

d. Tunnel Heater. Use a self-propelled unit capable of heating the underlying pavement while shielding the previously milled material from direct flame, and meeting **subsection 155.8a**. The tunnel heater may be equipped with a milling unit. In this case, the tunnel heater shall also meet **subsection 155.8b**.

e. Distributor-Paving Unit. Use a single unit that uniformly distributes the rejuvenator at the stipulated rate onto the scarified or milled material and mixes them together using a minimum of 2 telescopic milling heads. This equipment also screeds and finishes the scarified or milled material similar to an asphalt paver specified in **subsection 155.4**.

f. Milling-Mixing-Paving Unit. Use a unit complying with **subsection 155.8b**. The rejuvenator shall be added uniformly at the stipulated rate onto the scarified or milled material and mixed with a minimum of 2 telescopic milling heads. Alternatively, the rejuvenator may be added directly to the milling heads provide the applied rate is uniform across the width of the HIR material. This equipment shall also screed and finish the scarified or milled material similar to an asphalt paver specified in **subsection 155.4**. Alternatively, a self propelled independent paver complying with the asphalt paver specification in **subsection 155.4** may be used after the mixing operation.

155.9 COLD RECYCLED ASPHALT PAVEMENT EQUIPMENT (LIME SLURRY/FLY ASH)

a. General. Provide a self-propelled machine capable of cutting and removing the asphalt pavement (to the dimensions specified in the Contract Documents) in one pass. Equip the cutting machine with automatic controls capable of maintaining a uniform grade and cross slope.

Equip to pulverize the reclaimed asphalt pavement (RAP) material to specified requirements without contamination from the subgrade material. The RAP material processing unit shall consist of a closed loop system with a crusher and a scalper screen, or other approved devices capable of reducing the rap material to the specified gradation.

Provide the mixing unit with a continuous weighing system for the processed RAP material, and be coupled with meters to maintain the proper proportion of RAP material, liquid binder, set retarder (used only with fly ash) and water. Meter all water (including water added by the milling machine) introduced into the mix. If delivery of RAP material is stopped, automatically shut off the liquid binder, set retarder (used only with fly ash) and water pumps. Provide positive means for calibrating the weight measurement device and the additive metering devices.

Apply the additives in a mixing chamber that is capable of mixing the pulverized pavement material and additive to a homogeneous mixture. Equip the additive system to maintain the binder amount within plus or minus 0.2% of the specified application rate and to shut off automatically if delivery of RAP material is stopped. Place the mixture in a windrow or load it into trucks so segregation does not occur.

Place the recycled mixture without segregation using a self-propelled asphalt paver complying with **subsection 155.4**. If a pick-up machine is used to feed the windrow into the paver hopper, provide one capable of picking up the entire windrow down to the underlying materials.

Provide self-propelled vibratory steel and pneumatic rollers to establish the rolling procedure. The vibratory steel roller may also be used as a static steel roller.

b. Lime Slurry. Equip the milling chamber with spray bars to incorporate hydrated lime slurry and water into the RAP. The metering device for the spray bars is calibrated to, and controlled by the continuous weighing system for the RAP.

Provide slaking equipment specifically manufactured for this purpose. Equip transport, tank trucks or trailers with mechanical agitators.

c. Fly Ash. Provide equipment to introduce set retarder and water into the mix independent of one another.

155.10 HOT POUR CRACK SEALANT EQUIPMENT

Provide a machine used for pouring cracks, capable of mixing the asphalt and rubber or other specified material in the specified proportions into a homogeneous mixture at the specified temperatures. Use a double boiler melter with a permanently attached temperature gauge to continuously verify sealant temperature in the material tank. Do not use units with a solvent flush system for clean out, due to the risk of solvent contamination to the sealant. Use a melter with a heat chamber for hose storage and valve heating, or an air flush system to eliminate the need for a solvent flush clean-up system. Provide material tank mixing with a reversible paddle agitator in a vertical tank configuration. Use units similar to those purchased by KDOT Maintenance under Spec: MS 168.

155.11 MODIFIED SLURRY SEAL EQUIPMENT

a. Mixing Equipment. Use a self-propelled mixing machine capable of delivering and proportioning the aggregate, mineral filler, water, additives and emulsified asphalt to a revolving multi-blade dual mixer, and discharging the thoroughly mixed product. Provide storage capacity for all components to maintain a supply in the proportioning controls. Operate the machine continuously while loading, to eliminate unnecessary construction joints.

Provide individual volume or weight controls for proportioning each material to be added to the mix. Calibrate and properly mark each material control device. Provide controls accessible for ready calibration and placed so the Engineer may determine the amount of each material used at any time.

Equip the mixing machine with a water pressure system and nozzle spray bar to provide a water spray immediately ahead of and outside the spreader box as required.

Equip the machine with opposite side driving stations to optimize longitudinal alignment. Equip the machine to allow the mix operator to have full control of the forward and reverse speed during application of the material.

b. Spreading Equipment. Equip the machine with opposite side driving stations to optimize longitudinal alignment. Configure the machine to allow the mix operator to have full control of the forward and reverse speed during application of the material.

Spread the paving mixture uniformly by means of a mechanical laydown box attached to the mixer and equipped with paddles to agitate and spread the materials through the box. Design and operate the paddles so all the fresh mix shall be agitated to prevent the mixture from setting up in the box or causing side buildup and lumps. Flexible seals in the front and rear shall be in contact with the road to prevent loss of mixture from the box.

Equip the box with lateral movement controls. The rear flexible strike-off shall be adjustable. Rut filling equipment requires adjustable steel strike-off plates. Design and operate the spreader box and rear strike-off so a uniform consistency is achieved to produce a free flow of material to the rear strike-off without causing skips, lumps or tears in the finished surface. When directed by the Engineer, provide a secondary strike-off to improve surface texture. Use a secondary strike-off with the same adjustments as the rear flexible strike-off. Spread the mixture to fill cracks and minor surface irregularities and leave a uniform application of slurry on the surface. When directed by the Engineer, provide a secondary strike-off to improve surface texture. The secondary strike-off shall have the same adjustments as the rear flexible strike-off.

Operate the spreader to prevent the loss of the paving mixture when surfacing super elevated curves. Keep the box clean and free of build up of asphalt and aggregate.

SECTION 156

ROADSIDE IMPROVEMENT EQUIPMENT

156.1 SEEDING EQUIPMENT

a. Seeding Drills. Use drills for roadside seeding and fertilizing in good working order so that the rate of seed and fertilizer is applied at the rates shown in the Contract Documents. Two or more separate seed compartments may be necessary for seeding certain projects. Provide seed compartments capable of the accuracy needed to obtain the seeding rates shown for the various grasses, wildflowers and legumes listed in the Contract Documents. Use a drill that can apply commercial grass seed and wildflower seed, or a drill with attachments that would allow the application of fertilizer, grass seeds and wildflower seeds at the rate and depth specified in the Contract Documents. The drill must be approved by the Engineer. The Engineer will approve the width of the drill on the basis of the area to be seeded. The space of seed-tubes, disks and boots shall be a maximum of 8 inches. Provide drills that accurately control the depth of seeding and fertilizer placement to a maximum depth of ½ inch. Construct the seed and fertilizer compartments with partitions to prevent the material sliding to one side of the drill while operating on steep slopes.

b. Hydraulic Slurry Seeding, Fertilization and Mulching. Provide machines used for hydraulic seeding operations with continuous agitation of the slurry mixture during seeding operations. Equip with pressure to force seed and mulch material to the right-of-way line of most typical highway sections. The minimum tank capacity is 750 gallons.

156.2 MULCHING EQUIPMENT

a. Mulch Puncher. Use mulch punchers so weight may be added or hydraulic force from the tractor to push the puncher into the ground. Use notched discs with a minimum diameter of 16 inches for punching purposes. Provide discs that are flat or uncupped like notched coulters commonly used on moldboard plows. Place discs a maximum of 8 inches apart along the axle or shaft. Use shaft or axle sections of disks with a maximum of 8 feet in length.

156.3 OTHER ROADSIDE IMPROVEMENT EQUIPMENT

a. Cultipacker. Use cultipackers constructed so that sections are a maximum of 6 feet in length. Pull a maximum of 3 sections behind a tractor or drill at any time

b. Root "Sprigger". Acceptable spriggers are constructed so the root planting mechanism is driven by the tractor's power take-off to maintain a constant planting of roots on steep slopes. The machine shall be capable of planting roots in a continuous unbroken pattern. The Engineer will check the machine on a slab or hard ground with the power take-off running to determine if enough roots are being fed through the machine.

SECTION 157

OTHER EQUIPMENT

157.1 REBAR INSERTION EQUIPMENT

a. Drilling Equipment. Use equipment that complies with the following requirements:

- Hydraulic driven
- Capable of operation in a clockwise direction;
- Truck or trailer mounted;
- Adjustment in transverse and longitudinal directions;
- Capable of operating at a pitch of 45º;
- A power system to raise and lower the bit; and
- Removal of loose material by drill shaft vacuum extraction during drilling.

b. Epoxy Pump. Use a pump system that the manufacturer has certified to deliver a proper mixture of specific material properties and a given resin to hardener ratio. The given ratio is supplied by the epoxy manufacturer.

The pump may be adaptable for variable mixture ratios. It shall maintain the ratio set for a temperature range of 40 to 120ºF and a pressure range of 20 to 100 pounds per square inch. The pump shall include the separate A and B supply hoses along with their respective back-flow prevention valves.

c. Epoxy Mixer. Provide epoxy mixer with adequate elements to thoroughly mix the resin and hardener components and be capable of operating within the same temperature and pressure ranges as the pump system. Use an easy to clean mixer constructed of semi-transparent materials in order to observe the mixing operation.

d. Injection Nozzle Assembly. Provide an injection nozzle capable of temporarily locking into the 1 inch diameter hole in the concrete and holding a minimum sustained pressure of 100 pounds per square inch without significant surface leakage. A design for a suitable assembly is available from the Bureau of Materials and Research.

157.2 PILE DRIVING EQUIPMENT

a. General. Pile driving hammers other than drop hammers shall be of the size needed to develop the energy required to drive piles at a penetration rate of not less than 0.10 in. per blow at the minimum driving resistance according to the appropriate pile driving formula in **TABLE 704-1**.

In addition to all other requirements, single and double acting diesel hammers and air/steam hammers require the following.

(1) Open-End (Single Acting) Diesel Hammer. Equip open-end (single acting) diesel hammers with a device such as rings on the ram or a scale (jump stick) extending above the ram cylinder, to permit the Engineer to visually determine hammer stroke at all times during pile driving operation. Also, provide the Engineer a chart from the hammer manufacturer equating stroke and blows per minute for the open-end diesel hammer to be used.

(2) Closed-End (Double Acting) Diesel Hammer. Equip closed-end (double acting) diesel hammers with a bounce chamber pressure gauge, mounted near ground level so as to be easily read by the Engineer. Also, provide the Engineer a chart, calibrated to actual hammer performance, equating bounce chamber pressure to either equivalent energy or stroke for the closed-end diesel hammer to be used.

(3) The weight of the striking part of air/steam hammers used shall be a minimum of ⅓ the weight of the pile and drive cap, and in no case shall the striking part have a weight less than 2,750 pounds.

b. Hammers for Steel Piles, Steel Sheet Piles and Shells for Cast-in-Place Concrete Piles. If a gravity hammer is used for driving steel piles, steel sheet and shells for cast-in-place concrete piles, use one with a minimum weight of 3,500 pounds. In no case may the weight of the gravity hammer be less than the pile being driven plus the weight of the driving cap. In lieu of weighing the hammer, a certification may be provided by the Contractor. Equip all gravity hammers with hammer guides to maintain concentric impact on the drive head or pile cushion. Regulate the fall to avoid injury to the piles. The fall shall be a maximum of 15 feet. If steam or diesel

hammers are used, its rated gross energy in foot-pounds shall be a minimum of 2 ½ times the weight of the pile in pounds. The hammer shall develop a minimum of 6,000 foot-pounds of energy per blow.

c. Hammers for Pre-stressed Concrete Piles. Unless otherwise provided, drive pre-stressed concrete piles with a diesel or air/steam hammer that can develop an energy per blow at each full stroke of the piston of a minimum of 1 foot-pound for each pound of weight driven. The hammer shall develop a minimum of 6,000 foot-pounds of energy per blow.

d. Vibratory Hammers. Vibratory hammers may only be used when specifically allowed by the Contract Documents or in writing by the Engineer. If approved, vibratory hammers shall be used in combination with pile load testing and re-tapping with an impact hammer. In addition, 1 of every 10 piles driven with a vibratory hammer shall be re-tapped with an impact hammer of suitable energy to verify that acceptable load capacity was achieved.

e. Additional Equipment. The plant and equipment provided for air/steam hammers shall have sufficient capacity to maintain, under working conditions, the pressure at the hammer specified by the manufacturer. In case the required penetration or bearing is not obtained by the use of a hammer complying with the above minimum requirements, provide a hammer of greater energy or when permitted, resort to jetting or pre-drilling at Contractor expense. Use of the pile driving analyzer may be required when minimum requirements are not obtained or results are doubtful.

f. Leads. Construct pile-driving leads to afford freedom of movement for the hammer. Hold them in position with guys or stiff braces to support the pile during driving. Except where piles are driven through water, use leads of sufficient length that the use of a follower shall not be necessary. Leads shall be of sufficient length to allow them to be spiked into the ground at the onset of driving.

g. Hammer Cushion. Equip all impact pile driving equipment except gravity hammers with a suitable thickness of hammer cushion material to prevent damage to the hammer or pile and to maintain uniform driving behavior. Use hammer cushions made of durable, manufactured material that shall retain uniform properties during driving. All wood, wire rope and asbestos hammer cushions are prohibited. Place a striking plate on the hammer cushion to maintain uniform compression of the cushion material. Inspect the hammer cushion in the presence of the Engineer when beginning pile driving at each structure or after each 100 hours of pile driving, whichever is more frequent. Replace the hammer cushion whenever there is a reduction of hammer cushion thickness exceeding 25% of the original thickness, before continuing driving.

h. Pile Driving Head. Fit piles driven with impact hammers with an adequate driving head to distribute the hammer blow to the pile head. Axially align the driving head with the hammer and the pile. The driving head is guided by the leads and shall not be free swinging. The driving head shall fit around the pile head in a manner that prevents transfer of torsional force during driving while maintaining proper alignment of hammer and pile.

i. Water Jets. When jets are permitted, the number of jets and the volume and pressure of water at the jet nozzle shall be sufficient to freely erode the material adjacent to the pile. Use a plant with sufficient capacity to deliver a minimum of 100 pounds per square inch pressure at ¾ inch jet nozzles at all times. At a minimum of 5 feet before the desired penetration is reached, withdraw the jets and drive the piles to secure the final penetration with an approved hammer.

157.3 UNDERSEALING EQUIPMENT

a. Grout Plant. Provide a grout plant consisting of a positive displacement cement injection pump and a high speed colloidal mixing machine. Provide a mixing machine that operates between 800 and 2000 RPM, creating a high-shearing action with a subsequent pressure release to make a homogeneous mixture. Provide a pressure measuring gauge in the grout supply hose.

b. Drill. Provide an air compressor and rock drills or other devices capable of drilling the injection holes through the PCCP.

157.4 JOINT AND CRACK SEALING PCCP AND HMA EQUIPMENT

a. Air Compressor. Use an air compressor with a minimum capacity of 100 cubic feet per minute at 90 psi with a ⅝ inch hose (minimum). Use oil-free compressed air.

b. Applicator. For concrete pavement, use a sealant applicator head that completely fills the joints and cracks.

For asphalt pavement, use a sealant applicator head that completely fills the cracks.

c. Heating Pot. Prepare the material in a heating pot (400 gallon minimum capacity) equipped with an agitator that shall provide a proper mixing pattern to keep a consistent percent of fiber and maintain the heat distribution throughout the pot. Use equipment recommended by the sealant manufacturer.

d. Heat Lance. Use a heat lance manufactured by SEAL-ALL, L.A. HEAT LANCE, or another brand approved by the Engineer.