

154 – CONCRETE PAVEMENT AND CONCRETE STRUCTURE EQUIPMENT

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 $\frac{2}{3}$'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.

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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 than 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.

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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 to 12,000 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.

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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 $\frac{1}{4}$ 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 $\frac{3}{16}$ inch wide, spaced at $\frac{3}{4}$ inch centers and $\frac{1}{8}$ to $\frac{1}{4}$ 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.

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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 3/4 inch centers and 1/8 to 1/4 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.