Adjustment of Concrete Paving Equipment

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The construction of a concrete pavement has been compared to an assembly-line operation. But here the operation must be carried on out-of-doors, the product is stationary and the machines progress during the paving operation. Changes in weather conditions, concrete characteristics and pavement profile may require changes in the adjustment of the equipment and its operation to secure proper construction.

Any discussion of the proper adjustment of the mechanical equipment requires a brief outline of the function and operation of each machine. For them to properly shape and consolidate the concrete into a pavement slab they must operate at the proper time in respect to pavement placement, at the proper speed and they must be in proper adjustment.

Full advantage cannot be taken of the capabilities of the equipment without a knowledge of the adjustments that can be made in the various machines and the effect of these adjustments on the finishing procedures.

In some cases, pieces of equipment having similar functions are made by several different manufacturers. The details of adjustment may differ between manufacturers and between older and newer models of the same manufacturer, but in general the adjustments follow about the same pattern.

Although it is not the duty of the resident engineer and inspector to make the adjustments in any piece of equipment they should be able to direct the contractor's personnel in making them. To assist them in this important duty is the purpose of this paper.

●THE BROAD ASPECTS of concrete pavement construction have been set forth in a previous paper (1). This paper is primarily concerned with those aspects that have to do with the proper mixing, placing, compacting and finishing of the concrete into a slab with suitable riding qualities.

To secure this objective constant vigilance is required on the part of the inspector to insure that each piece of mechanical equipment is performing its function. Before any pavement is placed the equipment should be adjusted to conform to expected conditions. During construction minor adjustments will have to be made from time to time to adapt the operations to changes in weather conditions, concrete characteristics and pavement profile. Improper adjustment of any machine in the paving train makes the succeeding operations more difficult if not impossible.

It is not the intention that the inspector should make the adjustments in person. That is the duty of the contractor's personnel. However, an intimate knowledge of the various adjustments that can be made in the equipment is essential if the inspector is to determine if each machine is in proper adjustment.

Before starting any project the equipment should be checked for suitability. The

use of any badly worn or inadequate machine should not be permitted. Its use would only result in continuing unsuccessful efforts to keep it in adjustment.

A careful record should be kept of the adjustment settings of each piece of equipment. The time and stationing at which changes are made and the reason therefor should be recorded. By observing the effect on finishing of the various settings the inspector should develop the judgment required to properly direct necessary changes in adjustment.

In starting a project no effort should be made to achieve normal production. A leisurely pace on the first day will permit the crew to familiarize themselves with their duties without working under pressure. Furthermore, it will allow time for making adjustments of equipment without the finishing operations falling too far behind the placing of the concrete on the subgrade.

MIXING

The paver should be carefully checked to insure proper mixing. The items to be checked include any wear of mixer blades, the water system (Fig. 1), the air-entrainment dispenser (Fig. 2), is used, and the timing cycle.

Permissible wear of mixer blades is usually covered by the specifications. The usual limits are either 10 percent or $\frac{3}{4}$ in.

The amount of water discharged into each batch must be checked in order to keep accurate records of mix proportions. With the water gage set at various quantities, the water is drained off into a suitable container and weighed. If the amount discharged does not correspond to the gage setting, the indicator dial must be reset to show the correct amount.

While testing the water gage, the entire system should be inspected for leaks that would cause differences in the amount of water discharged into batches that are held in the paver for varying lengths of time.

The air-entraining agent dispenser should be tested as to the amount discharged at various settings. This test should be repeated at intervals as the agent may gum up in the dispenser, with consequent progressive lowering of the amount discharged. As the dispenser fills by gravity flow an air vent is essential and it should be kept clean at all times. The newer dispensers with a clear plastic cylinder are recommended as it will be readily apparent if they are failing to fill completely after each discharge.

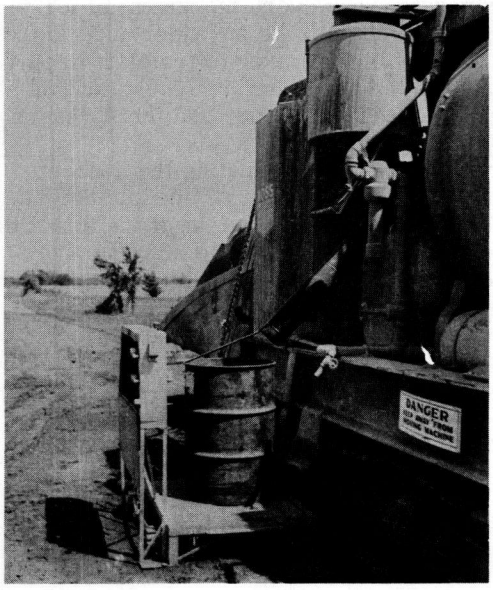

Figure 1. Checking the paver water system.

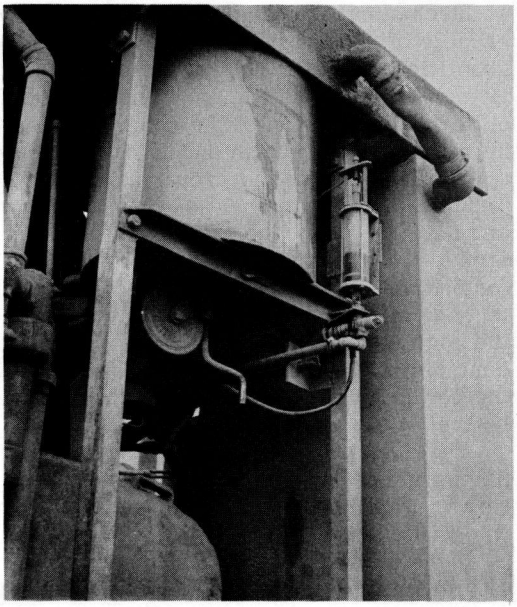

Figure 2. The air-entraining agent dispenser and piping must be kept clean.

To check the timing of the mixing cycle, the mixer should be operated at the manufacturer's recommended speed and a record made of the timing of the various automatic operations. These should be timed with a stop watch beginning when the skip reaches the top of its travel. For a dual-drum paver these include:

1. Time until water valve closes.
2. Time until discharge gate opens.
3. Time until transfer gate opens.
4. Time until discharge gate closes.

As soon as skip lock is released the skip should be started up in order that the operations may continue without interruption.

5. Time until transfer gate closes.
6. Time until discharge gate opens the second time.

The time from the starting of the stop watch until the discharge gate opens the second time is the gross mixing time. Under some specifications the transfer time (namely, the time the transfer gate is open) is not included in the mixing time and therefore should be deducted from the gross mixing time.

All pavers have a method of changing the timing of these operations to insure compliance with the specifications. These vary with different makes and will not be described here.

After operations start, the lapse in time between the skip reaching the top and the time when all solid materials are in the drum should be checked. This lag, if any, should be taken into account in setting the automatic controls.

After operations start some adjustments may be necessary in the automatic timing. When paving with the skip downhill the time the discharge is open may have to be lengthened to permit all of the batch to leave the drum. Conversely, when paving with the skip uphill this period may be shortened.

The U.S. Bureau of Public Roads film, "Lost Mixing Time in Dual Drum Pavers," shows in animated sequences the action that takes place during operations. A study of this film is recommended to inspection staffs and contractor's personnel.

SPREADING

Mechanical spreaders are used on almost all paving projects. These machines are capable of moving heavy loads of low-slump concrete. However, movement of large quantities of stiff concrete places unnecessary strain on both the spreader and the forms. By excercise of a little care and judgment on the part of the mixer operator to secure uniform distribution of the concrete over the subgrade, more uniform consolidation can be achieved, the strain on forms and equipment is greatly reduced, and the spreader operator can leave the proper amount of concrete for finishing.

Spreaders in general use consist of a screw or plow for distributing the concrete and a strike-off. The elevations of the bottoms of the distributing device and the strike-off are adjustable. The relationships of these elevations to that of the top of the forms are indicated on gages that are visible to the operator. Before starting a project the strike-off should be set with ends level with the top of the forms at which time the gage should read "0". If not, the gage should be adjusted to read properly. The controls of the elevation of the distributing device and the strike-off are independent and the bottom of the distributing plow or screw should be set about an inch higher than the bottom of the strike-off.

The ease and success of the finishing operations are dependent to a considerable extent on the uniformity in the amount of concrete left behind the spreader. This in turn is largely dependent on the skill of the spreader operator and his adjustment of the strike-off elevation.

If the mix is harsh and stiff, it will be inclined to tear and therefore the strike-off should be set higher for these mixes than for more fluid and sandy mixes that tend to surge under the strike-off.

Spreaders for use on projects constructed with central or transit-mixed concrete

are a recent development. One type consists of a hopper that moves across the slab on transverse tracks (Fig. 3). It is filled at the form line and discharges the concrete through a bottom gate. The amount of concrete deposited on the subgrade can be regulated by changes in the width of opening and the height of the bottom of the bucket above the subgrade. A strike-off behind the hopper can be raised and lowered by the operator for precise metering of the height of concrete left behind the spreader.

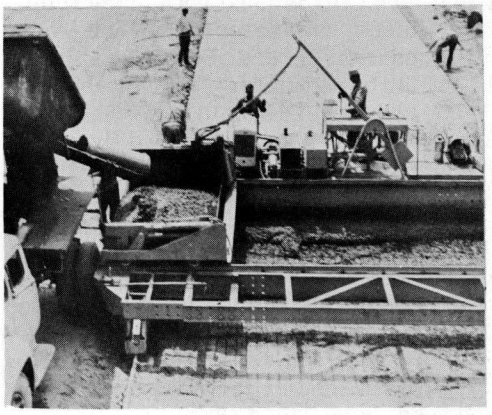

Figure 3. Hopper-type spreader for distribution of ready-mixed concrete.

Spreaders using conveyor belts for concrete distribution have been developed by several contractors for their own use.

If the concrete is to be consolidated by vibration, the pan or spud vibrators are often mounted on the rear of the spreader. It is important that these be operated only when the spreader is in motion. Some type of automatic cutoff to insure that this is always done is recommended.

Most specifications set forth the rate of vibration. This should be checked with a tachometer before starting construction. When pan-type vibrators are used the elevation of the bottom of the pan should be such that the coarse aggregate is far enough below the surface that little or no tearing takes place under transverse screeding. It should not be set so low that an excess of mortar is brought to the surface, but enough should be brought up for finishing. To obtain proper results several trial settings of the elevation of the vibrator will probably be required to secure the correct elevation of the bottom of the pan. The pan vibrators can be raised and if more than one pass is made they should be used only during the first pass.

The purpose of the spreader has been fulfilled if the surface of the concrete is such that the proper amount of concrete for finishing is left throughout the pavement width, and that, if specified, it is properly vibrated.

TRANSVERSE FINISHING

The consolidation of the concrete into a slab of proper shape is accomplished by transverse screeding. If properly performed these operations leave the surface close to final grade.

The transverse finishing machine usually consists of two oscillating screeds (Fig. 4). These are adjustable as to crown and tilt. Before starting a project the alignment of the bottom of the screeds should be checked (Fig. 5). To do this, first center the screed and lift it off the forms. Stretch fine wires taut between the forms at the front and back of the screed. Place uniform thickness blocks on top of the wires at each form and lower the screed on them. Check the alignment of the screed at both front and back edges for compliance with the specified surface contour and make any necessary changes by the front and rear adjusting bolts.

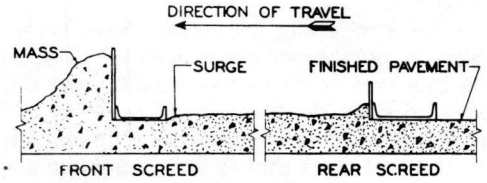

Figure 4. Diagram of screeds of finishing machine.

To assist in consolidation the front screed should be tilted, with the front edge slightly higher than the back. The amount of tilt is dependent on the characteristics of the concrete. Harsh, dry mixes may tear under a flat screed and leave insufficient mortar for finishing. To offset this the screed should be tilted about ¼ in.

If this much tilt is used with more fluid, sandy mixes, an excessive amount would surge under the screed. For these mixes the tilt should be reduced to $\frac{1}{8}$ in. or less.

The rear screed should be set flat or with not more than $\frac{1}{16}$-in. tilt. If two finishing machines are used both screeds on the rear machine should have little or no tilt.

The ends of the screeds on conventional finishing machines rest on the forms. As these areas are subject to the greatest wear, removable end plates are provided. These plates should be inspected at intervals for excessive wear. Abrasion up to about $\frac{1}{8}$ in. can be compensated for by raising the entire screed by the adjusting bolts. In case of greater wear the plates should be reversed or replaced (Fig. 6).

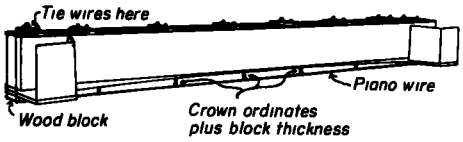

Figure 5. The crown of all screeds should be adjusted to produce proper crown.

All finishing machines are provided with transmissions for variations in both forward speed and number of screed oscillations and with adjustable eccentrics for changing the length of the screed stroke. For stiff harsh mixes these should be set for rapid lengthy strokes combined with slow forward motion to assist in working up sufficient mortar for finishing. For more workable mixes the oscillations should be shorter and less frequent in combination with faster forward motion.

In addition to specific adjustments an over-all inspection of the machine should be made for general condition. All wheels should be equipped with scrapers to prevent accumulation of concrete. These should be kept tight so that they will act as snubbers in addition to cleaning the wheels. The lift chains should be long enough to remain slack at the ends of the screed stroke. If too short they will tighten at the end of each stroke and there will be a tendency for the screed to lift off the forms.

Within the last few years several new types of finishing machines have come into use. These are all carried on long wheel-base frames (Fig. 7) and finish the concrete with transverse oscillating screeds and a stationary float. All of them are provided with some method of checking their contour. In addition some of the screeds or floats do not ride on the forms but are suspended from the frame. Their elevation is therefore much less affected by minor form irregularities. Before starting a project these should be set at about the elevation of the top of the forms. The screeds should be set so that each one is slightly lower than the one preceding. In this way the small amount of material necessary for proper finishing will be carried ahead of each screed. After starting a project there will have to be minor adjustments in the elevation and crown of the screeds to produce a proper finish.

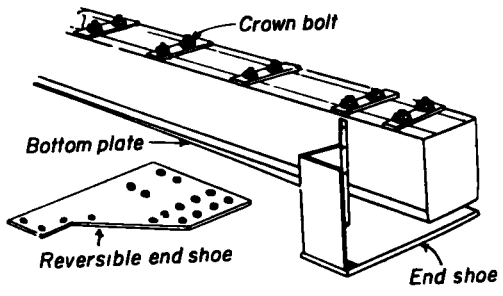

Figure 6. Worn end shoes or transverse screeds should be reversed or replaced.

LONGITUDINAL FLOATING

When used, the longitudinal float is the last finishing machine in the construction train. Its purpose is to correct any minor irregularities so that the surface will meet specification tolerances. To fulfill its function it must be kept in correct adjustment within very close tolerances at all times.

If the preceding operations have been properly performed there will be little for this machine to do beyond eliminating the marks left by the transverse screeds of the finishing machine. In such cases a longitudinal float that is not in proper adjustment may ruin a good surface left by the preceding machines.

Figure 7. Long wheel-base finishing machine.

There will be times when, due to irregular forms, lack of uniformity in concrete proportions or changes in vertical or horizontal alignment surfaces will develop that do not meet specification tolerances. Here again proper adjustment of the longitudinal float is essential if these are to be corrected.

Adjustments of longitudinal floats may vary between manufacturers but in principle they are similar. The purpose is to maintain the float parallel to the top of the forms and at the proper elevation at each point in its travel. All machines suspend the float from transverse tracks at the front and rear of the machine. To maintain proper adjustment the support for the tracks must be stiff enough to resist deflection as the float moves across the pavement.

The first adjustment is to straightedge the float along the centerline and both edges. If not straight it should be corrected before any other adjustments are made.

The height of the tracks that carry the float assembly should be checked to make sure that all four ends are the same distance above the plane of the bottom of the wheels. The proper height for any model is given in the manufacturer's operating instructions. This should be measured from a wire placed under the wheels on each side rather than from the forms as there may be some irregularity in their elevation. The track must be flat when this adjustment is checked (Fig. 8).

The tracks are then set to conform to the design crown. The method of making this adjustment varies considerably between manufacturers. In all cases the float should be weighted with approximately the same load it will carry during construction, including the operator.

One make employs a double track at each end of the float. One of the two is always flat and should be set from a wire stretched from end to end. Each end of the wire is

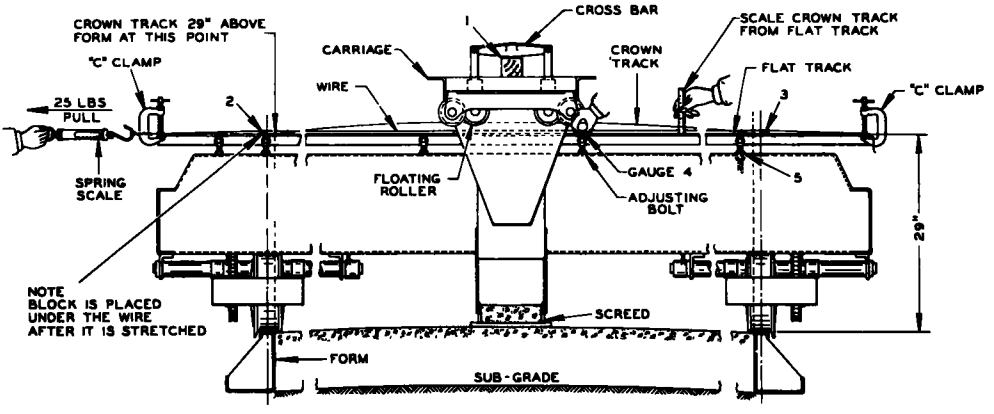

Figure 8. On longitudinal floats with double tracks one is always set flat.

raised on a ½-in. block and the track put in alignment by adjusting bolts. The other track is then set to design crown by measuring up from the flat track.

In this type the crown can be removed in increments by adjustment of quadrants at both ends of the float carriage (Fig. 9). Cranks attached to the quadrants are used to set the screed. Each quadrant is equipped with a scale divided into ten sections so that the proportion of the crown removed can be determined.

Another make uses only one track at each end, which can be changed from full crown to straight position by cams. The position of the cams is controlled by a rod which is moved back and forth by a wheel operating a worm gear (Fig. 10). On the worm are markings to indicate the proportion of the total crown remaining in the track. To adjust this type the cams are first set in the position for a straight track and its alignment checked from a wire. The cams are then turned 90 deg to the position they occupy when full design crown is being used. The length of the cam arms are then adjusted to produce the desired crown.

The float must be parallel to the top of the forms and at the proper elevation. All types are provided with turnbuckles or rods that control the distance between the track and the bottom of the float. Both the height of the float and the relative elevation of the two ends can be adjusted. While the float should normally be parallel to the top of the forms it may be necessary to raise the front end slightly on downgrades and raise the rear end on upgrades.

The float should be parallel to the crown of the slab in a transverse direction. This adjustment is made by centering the screed between the forms and measuring the height of each edge above a wire stretched between the forms. This should be done at both ends of the float. The method of correcting any error requires only the turning of bolts in some models but may involve addition of shims under bearings in others.

It is essential that both the wheels and the forms be free of concrete in order for the float to function properly. All machines are equipped with scrapers that act on the

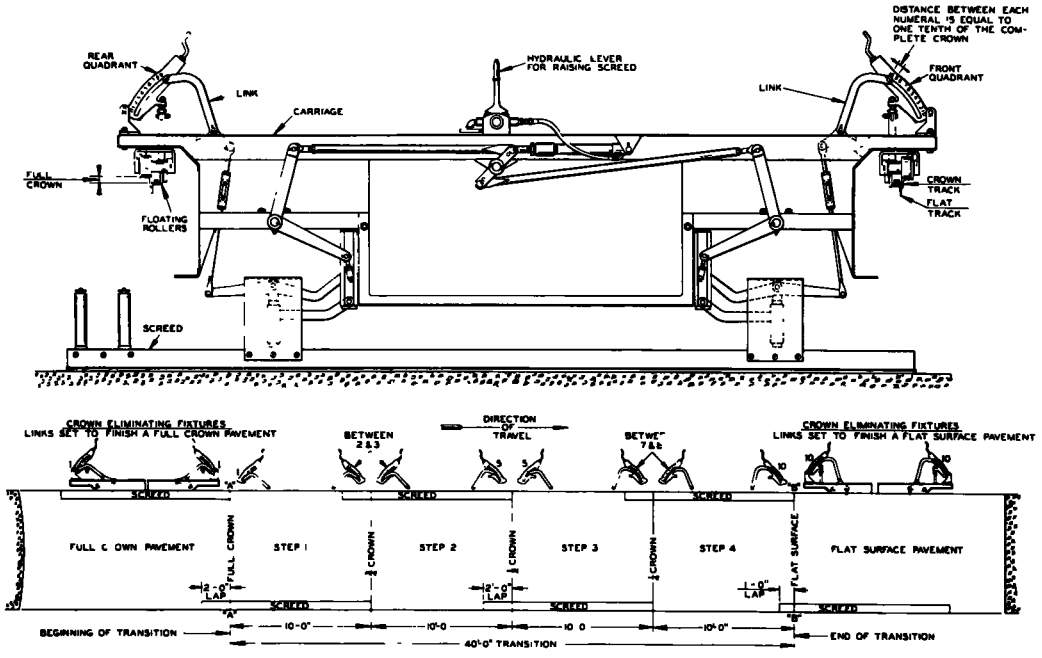

Figure 9. Adjustable quadrants at ends of float assembly permit changes in crown.

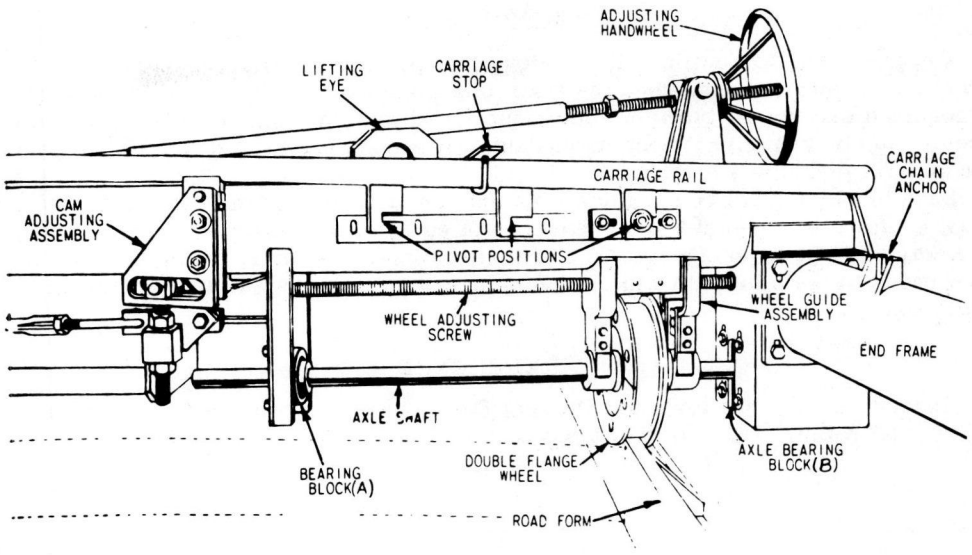

Figure 10. Crown changing cams are changed by use of adjusting handwheel.

wheels and on the forms. They should be kept in tight contact with the wheels or forms at all times.

Chain drives are used for longitudinal movement of the machines and transverse passage of the floats. These are provided with idler sprockets or take-up bolts so that the chains will not become too loose. Loose chains result in excessive slap and racking of the equipment.

MEMBRANE CURING

If membrance curing compound is used the equipment for its use should be checked for compliance with specifications (Fig. 11). These frequently require two coverages and the relationship of forward travel to transverse movement of the spray equipment should meet this requirement. The rate of application can be checked by the coverage obtained per barrel.

Other features that should be checked include the method of agitation of the compound and the height and type of nozzle and amount of pressure. Agitation can be either mechanical or by air as required by the specifications and should be sufficient to keep the pigment in suspension. The nozzle and applied pressure should be such that the compound is discharged as a fine spray. The spray should be protected from fine spray. The spray should be protected from air currents by a hood. The elevation of its bottom should

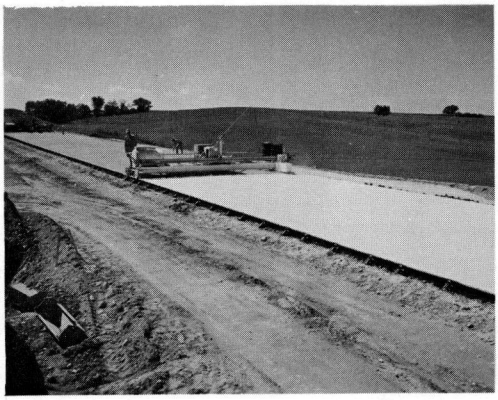

Figure 11. Coverage by membrane cure machine should be adequate and uniform.

be low enough to protect the spray but not so low as to receive an excessive amount of the material.

CONCLUSION

The preceding has outlined the various machines in general use for finishing concrete pavements and described the method of placing them in proper adjustment. It is recognized that not all types of equipment have been covered nor have all factors that require minor adjustment been discussed, but enough has been described to point out the general principles involved.

Each machine must be considered as only one unit in a series and its adjustments must conform to those of the other pieces of equipment in the paving train. Only in this way can full advantage be taken of their capabilities for reducing hand-finishing operations to the minimum and producing pavements having satisfactory riding qualities.

REFERENCE

1. Peyton, R. L., "Criteria for Present Day Concrete Pavement Construction." HRB Bull. 162, pp. 1-7 (1957).